Arbejdsrapport

1998

Emission of Volatile Oganic Compounds from Wood and Wood-Based Materials

APPENDICES

Miljøministeriet **Miljøstyrelsen**

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Appendix 1
Project Partners

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Project Partners

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Appendix 2
Project Organization

Appendix 2
Project Organization

The project has been carried out in collaboration between the project partners of the working group, see Appendix 1.

An advisory committee headed by Elisabeth Paludan, Danish Environmental Protection Agency, have supported with advice and guidance during the project. The members of the advisory committee represented:

Danish Environmental Protection Agency
Danish Working Environment Service
National Housing and Building Agency
The Association of Danish Woodworking Industries
The Association of Danish Paint and Varnish Industries
The Association of Danish Designers
Danish Furniture Retailers Organization
The Timber, Industry and Construction Worker's Union in Denmark.

Appendix 3
Test Method

Appendix 3
Wood-Based Products Standard Test Method for the Determination of VOC Emission

Contents

0. Foreword

This standard was coordinated internationally with the work in CEN/TC 264/WG7:"Indoor air quality - Emissions of chemical substances from building materials." Concerning wood-based products the content was coordinated with Nordic Wood research institutes.

1. Scope, Principle and Field of Applications

1.1 Scope and Principle

This standard specifies a general laboratory test procedure for the determination of the chemical emission of volatile organic compounds from wood-based products to the indoor air.

Test specimens (representing the product to be tested) with a known surface are placed in a test chamber with well defined and constant test conditions, including air temperature, relative humidity and air velocity parallel over the test specimen.

Gases and vapours emitted from the test specimen are mixed with the air in the test chamber. The air is analyzed by chemical analyses.

The measured emission of individual compounds are given as concentration (in test chamber) and emission rates. The emission can be converted into concentrations of individual compounds in the indoor air by use of a model room calculation.

The emission measurements are carried out under defined climate conditions in emission test chambers.

The test chamber in principle is given in Annex 1 of this standard. For further description of the chambers, chamber requirements, chamber materials etc. please refer to e.g. Ref.1.

1.2 Field of Application

The standards cover the following wood-based materials and products: boards, panels, floors and furniture including accessories and subsidiaries as they are delivered from the supplier/manufacturer.

The emission determined according to this standard can be used as documentation of emission from wood and wood-based materials and products to the indoor air.

2. Normative and Informative References

This standard is based on:

- Building products - Determination of volatile organic compounds - Emission test chamber method. Working drafts of CEN/TC 264/WG 7, Octobre 1995 - March 1997. (Ref. 1)
- Danish Society of Indoor Climate. Standard Test Method for Determination of Emission from Building Products. 1. edition, December 1994. (Ref. 2)
- DS-Information. Directions for the determination and evaluation of the emission from building products. DS/INF 90, 1. edition. 1994-03-22. (Ref. 3)
- Guideline of Volatile Organic Compounds Emitted from Indoor Materials and Products using Small Chambers. COST project 613, WG 8, Report No 8, EUR 13593 EN, 1991.
- Nordtest, Building Materials: Emission of Volatile Compounds, Chamber Method. Nordtest Method, NT BUILD 358, Nordtest. Espoo 1990. (Ref. 4)
- Tirkkonen, Tiina et.al., Evaluation of Tenax TA absorbent as a collection medium for volatile organic compounds in indoor air and material emission measurements, including appendix 2: Sampling and Analysis Instructions, NKB, 1995.
- Trade Standard: Measurement of Chemical Emission from Flooring Materials. Swedish National Flooring Trade Association and Swedish National Testing and Research Institute. Stockholm 1992-09-03.
- Possanzini M. and DiPalo, V.: Determination of Olefinic Aldehydes and Other Volatile Carbonyls in Air Samples by DNPH-Coated Cartridges and HPLC, Chromatographia Vol 40, 134, No. 3/4, February 1995.
- Wood-based panels. Determination of formaldehyde release. Part 1: Formaldehyde release by chamber reference method. European Standard prEN 717-1, April 1996.

3. Definitions and Abbreviations

Air exchange rate n [h^{-1}]
The ratio of volume of clean air brought into the test chamber hourly and chamber volume measured in identical units.

Emission
Emission of gases and vapours from a material to the surrounding air.

Emission rate R [µg/(m^2h) or mg/(m^2h)]
The term is in this context used as the mass emitted per time unit and area unit.

Emission profile
Curve with the concentration as function of the time.

Headspace-analysis
A method primary to determine which gases are emitted from a material. The method is used prior to the testing or at the start of the testing to identify the compounds, which the specimen emits.

Indoor climate (indoor air quality)
The air including contaminants inside rooms for human beings e.g. residences, institutions and offices. In other contexts indoor climate is often used in a wider sense.

Loading factor [m^2/m^3]
The ratio of the surface area of the test specimen and the volume of the chamber.

VOCs (Volatile Organic Compounds)
The VOC's are gases under normal indoor climate conditions. The VOC's can be divided into different chemical groups:

- Hydrocarbons, aliphates, terpenes (cycloalkenes), aromates
- Hydrocarbons, chlorinated
- Alcohols
- Aldehydes, ketones
- Carboxylic acids,
- Esters, glycols, glycol ethers and esters
- Other VOC's: amines, siloxanes, sulphur containing compounds, isocyanates

Standard room
A fictive model room used as the basis for general calculations of indoor air concentrations for comparison of measured material related concentration with acceptable concentrations of the indoor air. The dimensions of the room and the size of the exposed surface of different building products in the room are defined in this standard.

Test chamber
The chamber can be considerably smaller than general living rooms. The test chambers have controlled climate and shall fulfil a number of requirements.

4. Emission Testing

In the following test conditions and procedures on how to perform the test are given in brief. For further details please refer to e.g. Ref. 1 or Ref. 2.

Recovery studies shall include toluene and dodecane. A recovery of $ 80% shall be guaranteed for each target compound.

4.1 Sampling from Production

The manufacturer and supplier sample the test specimen(s) directly from the production. The test

specimen shall be representative for the production, the production time and the product.

The samples shall be marked with an unmistakable identification code. Solvent-based ink pens or other marking methods that may contribute with VOCs must not be used.

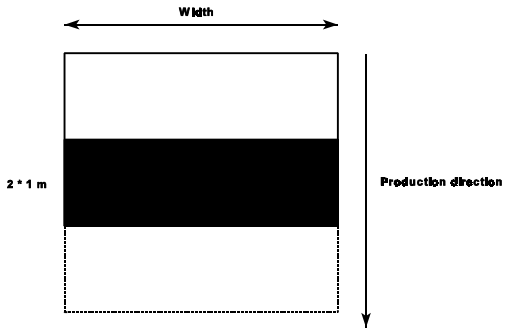
The specimen(s) shall be accompanied by a data sheet where the following data is to be registered:

- Production week and other production data
- Manufacturer
- Packing week
- Product name
- No. of test specimens
- Size of test specimen
- Other observations which might influence the test result a.o. wood species, drying conditions, ageing/storing, moisture content, additives

Sampling from production of the individual wood products are stated below.

Boards

Minimum 2 boards are sampled from the production, as panels about 1 meter in length (in actual manufactured width and panel thickness) is cut from the middle of the board according to the sketch below. The panels are sealed airtight, e.g. in polyethylene foil and the sample is forwarded for testing.



Panels

Samples taken from the production are stacked and packed as panels are normally packed. The samples are forwarded for testing.

Floors

Samples are taken from the production stacked and packed as wood for floors are normally packed. The samples are forwarded for testing. Possible additives such as glue and varnish are delivered for testing in unbroken packing.

Furniture

Samples are sampled from the production and packed as normal prior to shipment.

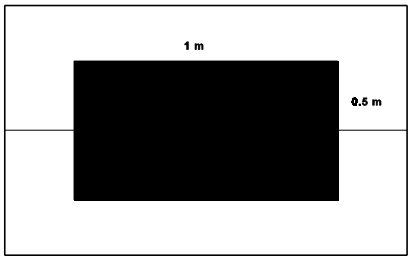
The furniture is forwarded for testing.

4.2 Preparation of Test Specimens

The laboratory will adjust the test specimen area in relation to chamber volume in order to obtain the required load. A ratio of n/L = 1, where L = loading factor and n = air exchange rate is recommended.

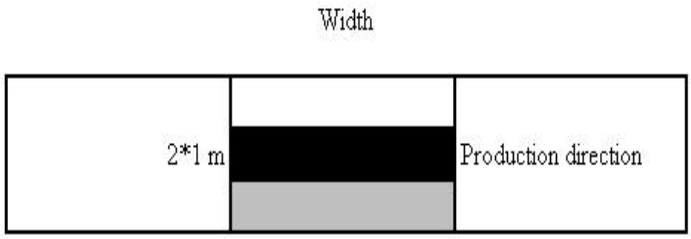
For wood products, where the emission is expected to vary within the test pieces and from wood piece to wood piece, the following shall furthermore be registered when possible: Relative surface area of hardwood/sapwood and knots for the area of the individual test specimen which is exposed in the chamber.

Preparation of test specimens for the individual wood products are stated below.



Boards

Test specimen for emission testing will be sampled as shown on the sketch below.



The edges of the test specimens are sealed airtight by use of low emitting aluminum tape.

Panels

Test specimens for emission testing are sampled from the middle of the package.

Floors

Test specimens for emission testing are sampled from the middle of the package.

When testing parquet floors the parquet rods and boards are joined together according to the guidelines of the manufacturer/supplier. Test specimens for emission testing are cut according to the sketch below:

Asa principal rule wooden floors are tested including the glue recommended by the manufacturer. Type of glue, description, brand, application method, application time and amount etc. are stated. To obtain conditions as close as possible to reality between jointings and surface, the test specimens for testing are cut, so that the width of the parquet rods (shortest side) makes out the longest side of the test specimen.

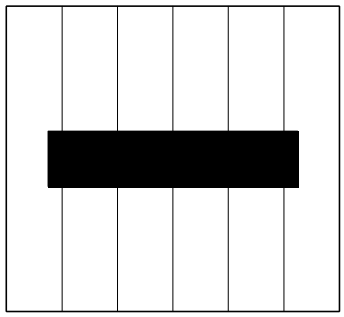
Testing of a varnish for treatment of floors is generally based on testing of the varnish coated on a wooden substrate. The substrate, application method, applied amount, number of coats, intervals between coating etc. follow the guidelines given by the manufacturer/supplier.

Furniture

As a principal rule furniture is tested so complete as possible and the emission from all materials are measured during the same chamber exposure that means including additives e.g. lacquer and oils, accessories e.g. hinges.

If it is necessary to cut up a piece of furniture, then all the cut edges should be sealed airtight with aluminum tape or foil.

When sampling parts of furniture, the relative area between the individual materials/material compositions has to be the same as that of the furniture in full



size.

A miniature piece of furniture can be tested joined together as one object or in several parts, as long as the testing takes place by the same chamber exposure. If a test specimen is tested in several parts, then normally adjacent areas are sealed prior to exposure.

Surfaces and edges which in practice are untreated are as a principal rule tested without sealing, while surfaces and edges which in practice are surface treated are tested with the actual surface treatment. In cases where it in practice is hard to perform the actual surface treatment e.g. a cut edge, the edge in question could be sealed with tape. In this case the edge area sealed with tape does not form part of the area calculation.

4.3 Conditioning of Test Specimens

The test procedure is initiated not later than 4 weeks after date of production. From the time the product is released from the manufacturer for sale to start of testing, the samples are stored in unbroken packing at the laboratory at normal room temperature. If the original packing is not air tight, the sample should be packed in emissionfree plastic, e.g. polyethylene foil.

If the samples have not been prepared immediately before the testing, they will be stored in emissionfree plastic at room temperature.

During the total conditioning period the test specimens kept at the standard test conditions, see part 4.4 Standard test conditions.

4.4 Standard Test Conditions

Standard test conditions:

- Relative humidity 45±5 % (alternatively 50±5 %)
- Air temperature 23±0.5EC
- Air velocity parallel over the middle of the test specimen 0.15±0.05 m/s
- Loading factor and air exchange rate ratio: n/L = 1.

4.5 Measurement Times

The time 0 is defined as the time when the packing is opened and the test specimen is placed in the test chamber.

Regarding products with an unknown emission profile the emission is determined over a period of at least 28 days with sampling in at least 3 periods after e.g.:

3 days
14 days
28 days

Additional measurements should be agreed upon in the individual cases.

The mean between the starting and closing time of sampling is used as the measuring time. Measuring-intervals depend on kind of chamber and test conditions.

There are no universal calculation models for determination of the emission profile.

4.6 Chemical Analysis

4.6.1 Initial analyses, optional

Formulas, samples of materials/components etc. are given as supplementary information to the laboratory.

For unknown samples an initial qualitative headspace analysis could be carried out in order to determine the programme for analyses including selection of the gases and vapours, on which the evaluation is based.

The analysis programme is determined according to the detailed objective of the testing, considering as a minimum the following types of VOCs including:

- Aldehydes
- Amines
- Isocyanates
- Sulphur containing compounds

4.6.2 Chemical Emission Testing

Chemical emission measurements include as a minimum:

- Individual VOCs by use of Tenax and charcoal sampling tubes and gas chroma-tography
- Formaldehyde by acetylacetone-method, e.g. according to prEN 717-1
- Aldehydes by use of dinitrophenylhydrazine reagent tubes, acetonitrile extraction and liquid chromatography.

The detection-limit for individual VOCs should be aimed at approx. 1 µg/m^3 (test chamber concentration). All individual VOCs in concentrations in the test chamber) over 5 µg/m^3 and compounds selected for determination should be identified.

4.6.3 Result of Chemical Emission Testing

The measured emission of individual compounds are given as concentration (in test chamber) and emission rates.

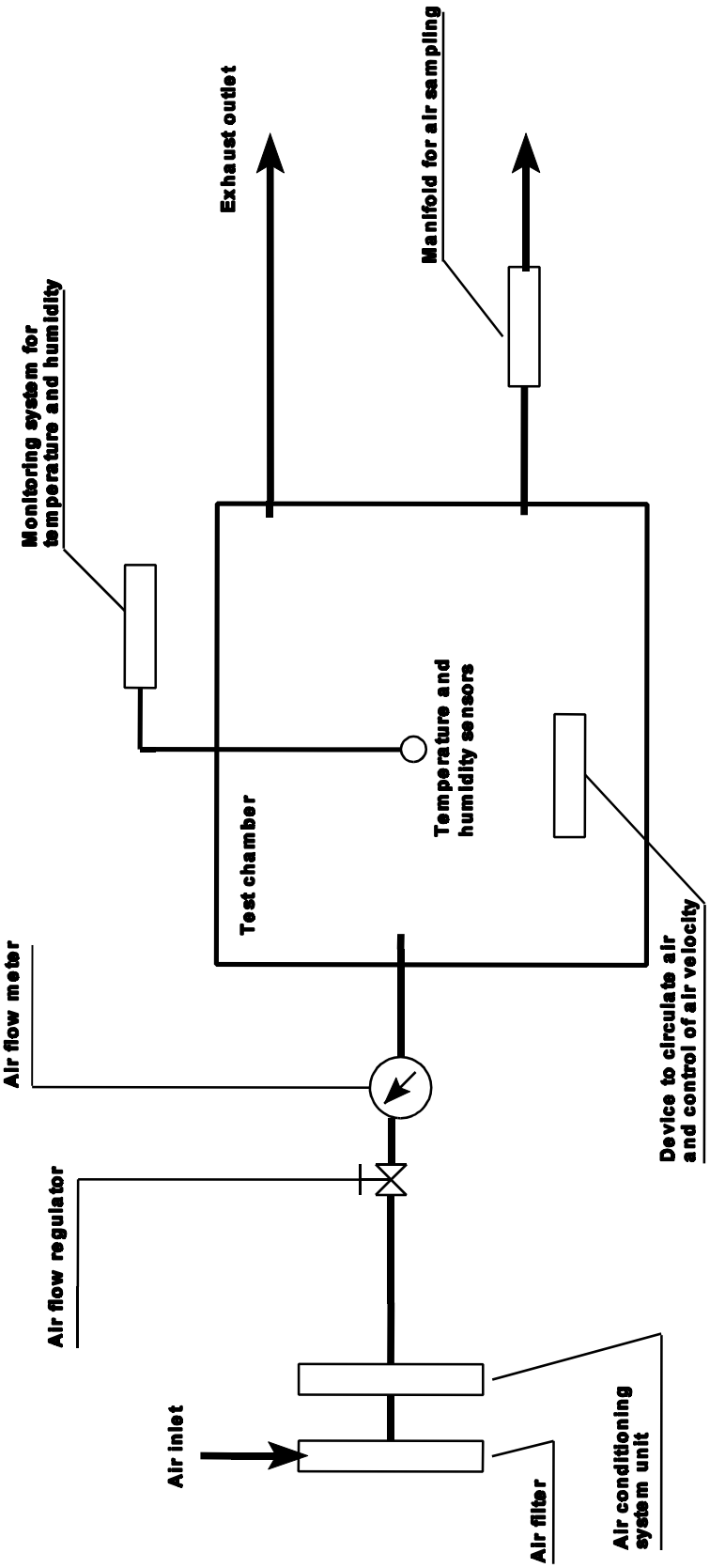
The emission can be converted into concentrations of individual compounds in the indoor air by use of a model room calculation according to Ref. 2, Ref. 3 and Ref. 4.

A test report should as a minimum contain the points given in Annex 2.

4.7 Evaluation of Result

The reported results can be used in declarations. The results can e.g. be converted to time-values by comparing model room concentrations and threshold values for the individual compounds of concern.

Annex 1


Exhaust outlet
Manifold for air sampling
Monitoring system for temperature and humidity
Temperature and humidity sensors
Test chamber
Device to circulate air and control of air velocity
Air flow meter
Air flow regulator
Air inlet
Air filter
Air conditioning system unit

Annex 2

A test report should as minimum contain the following:

Name and address of the testing laboratory
Unique identification number of the test report
Name and address of the assignor
Purpose of the test

Description and identification of the test objects, a.o.:

- Trade name
- Production no. and time of production
- Other identification marks of the test objects including composition, structure, colour
- Presented information in writing e.g. formula, data sheets for the product and raw materials of the product respectively

Date of unpacking
Date for receipt of the test objects.
Method of sampling.
Ageing and conditioning of test specimens.
Date for start and closing of the testing.
Description of test methods and test procedures.
Description of test chambers including type and test conditions.
Description of other equipment.
Any deviations from the test method

Measurements, assessments and concluded results a.o.:

- Documentation for selection of analysis programme
- Test conditions incl. measuring times
- Emission rate for examined individual compounds

Inaccuracy and uncertainty of the test results
Date and signature of the person who is technically responsible for the report.
Statement whether a result only relates to the examined specimen.

Appendix 4
Indoor-Relevant Time-Value

Appendix 4
General Principles for Evaluation Based on Indoor-Relevant Time-Values

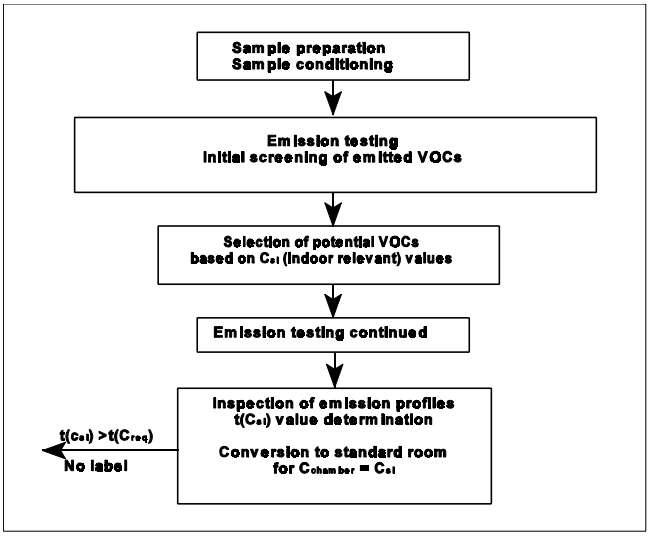
This Appendix gives a description of an evaluation of emissions based on indoor-relevant time-values as used in the Indoor Climate Labelling concept, described by Danish Society of Indoor Climate, DSIC, for documentation and labelling of the influence from building products, furniture and other products used indoors.

The basis of the concept is an indoor-relevant time-value based on chemical measurements of primary source emission of VOC's and on sensory evaluation.

The documentation and labelling concerns the indoor air properties, which a new product is expected to have, when it is installed in the building. According to the DSIC the indoor-relevant time-value has to be accompanied by indoor related guidelines for storage, transportation, installation, use, cleaning, maintenance etc. in order to describe a possible impact of the product on the indoor air during the total period of use. The chemical measurements of the VOC emission is based on a determination of individual chemical substances. When the indoor-relevant time-value is determined from the chemical analyses a sensory evaluation of the acceptability and intensity of the air is carried out at the time corresponding to the time-value based on chemical testing. The sensory determination is used as a total and supplementary determination of the air quality.

However, within this project the evaluation has been restricted to source emission determined by chemical analyses besides informative sensory determination of three materials.

A summary of procedures for testing and evaluation carried out within this project are given below. The total concept is given in DSIC ref. 1-3.



C_{si}: Concentration of VOC_i in standard room
$t(C_{si})$: Indoor-relevant time-value
$t(C_{req})$: The maximum allowable time-value for labelling

The indoor-relevant time-value is defined as the time it takes to reach down on a defined acceptable concentration of the indoor climate in a standard room under standard conditions.

To phrase it popularly the indoor-relevant time-value is the time it takes from a product is installed till the emissions of all single substances are down at an acceptable concentration in the indoor air - based on odour and mucous irritation thresholds and standard room considerations. A declared time-value of, for example, 10 days means that the probability of the product to cause odour or to cause irritation in eyes, nose and upper respiratory passage is insignificant later than 10 days after installation of the product.

The result given as a single indoor-relevant time-value is determined by converting chamber concentrations measured by chemical analyses to concentrations in a standard room and compared with odour thresholds and mucous membrane irritation thresholds.

When generally accepted indoor air threshold values concerning carcinogenic and allergenic effects are defined, these health effects will be included.

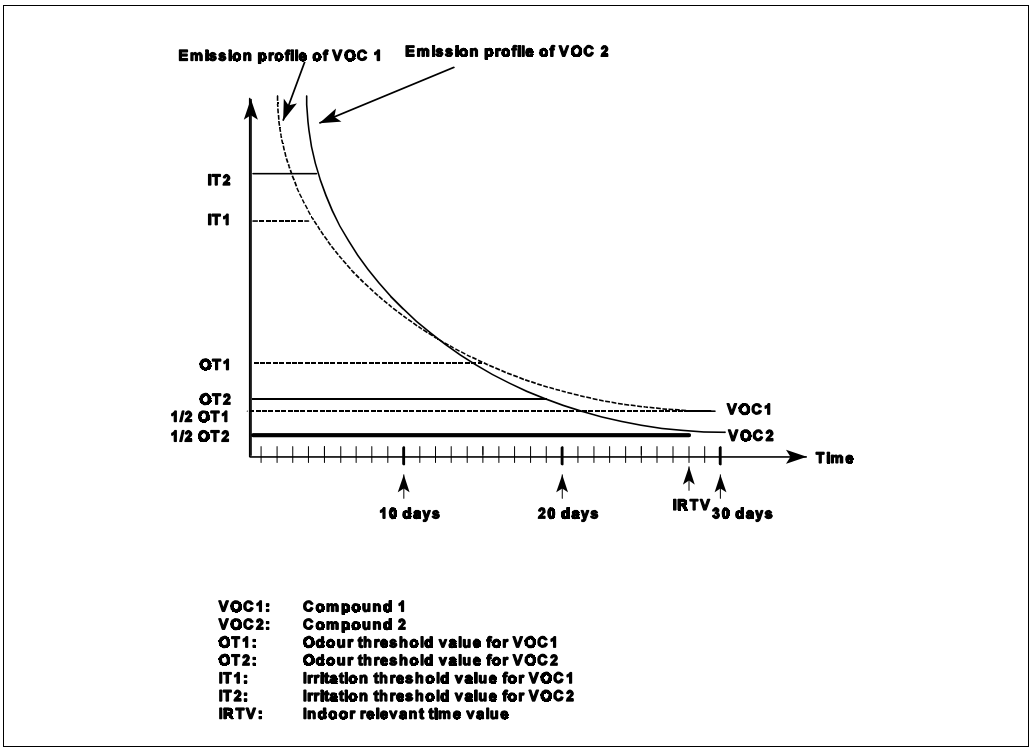
Descriptions and calculations in more details are given below and in Atest method for determination of emission from building products" (DSIC1). Additional information on the technical background, assumptions, limitations and indoor comfort evaluation is given in (DSIC2), (DSIC3) and (DSIC4).

Principle in Determination of the Indoor-Relevant Time-Value

The determination of the indoor-relevant time-value of a product is based on the time, it takes the slowest emitting individual chemical substance with the lowest indoor-relevant odour or irritation threshold to reach half of this value in a fictive standard room (DSIC5) and (DSIC6).

The standard room used for general calculations of indoor air concentrations has a relatively large surface area compared to the room volume, see last part of Aconversion of concentrations from test chamber to air in standard room@.

In the example shown below, VOC2 showed to be the slowest emitting single substance, and to have an odour threshold value, which is lower than the irritation threhold value. The time-value corresponding to 50% of the threshold value based on VOC2 was found to be 28 days from the crossing of emission profile curve of VOC2 converted to standard room concentration and half of the odour threshold value line. The product was given a declared time-value of 30 days.



Air quality comfort thresholds for more than 800 chemical substances as well as other physio-chemical parameters are given in the databank AVOCBASE@ (DSIC4), which is the reference databank of the laboratories.

The odour often becomes the determining factor, as the odour thresholds generally are magnitudes lower than mucous membrane irritation thresholds and thresholds of more severe effects.

Determination of the Indoor-Relevant Time-Value based on Chemical Analyses

The determination of the indoor-relevant time-value includes the following steps:

- Result of chemical analysis of air from test chamber
- Conversion of concentrations from test chamber to air in standard room
- Calculation of indoor-relevant time-value based on chemical analyses

Result of Chemical Analysis of Air from Test Chamber

The calculation based on results from chemical analysis of air samples collected from the test chamber is carried out according to the following procedure.

The concentration changes all the time in the test chamber, also while the sampling takes place. The concentration, $C_{ki,\,measured}$, which is measured, is, therefore, an average value of the equilibrium concentration over the sampling time. The equilibrium concentration will in most cases change so little in time that it can be considered constant during usual sampling times, usually less than a couple of hours.

By repeated measurements the measured concentration should be given as function of the measuring time. The graduation of the axes should be adjusted to the size of the concentrations and to the size of the measuring times, the axes should start with zero.

The curve, which the points indicate, is the emission profile of the measured substance. The same test specimen may have different emission profiles for the different substances.

The concentration in the test chamber can not be compared directly with the acceptable concentration of the indoor air quality, therefore, the emission rate in the test chamber is defined in the formula below.

where:

$$R_{ki} = \frac{C_{ki} \times n_k \times V_k}{A_k}$$

R_{ki}	*is the emission rate in the test chamber for the compound "i", µg/(m²⋅h) or mg/(m²⋅h)*
C_{ki}	*is the concentration in the test chamber of the compound "i", µg/m³ or mg/m³*
n_k	*is the air exchange rate in the test chamber, h⁻¹*
V_k	*is the volume of the test chamber, m³*
A_k	*is the test specimen's exposed area in the test chamber, m²*

The area divided by the volume is called the material loading.

Conversion of Concentrations from Test Chamber to Air in Standard Room

The concentration measured in the test chamber should be converted to a concentration in a fictive standard room representing the indoor air quality. It is assumed that the emission rate is the same in the test chamber as in the standard room, which implies that the test chambers used give completely uniform concentration conditions.

The emission rate in the standard room is defined below:

$$R_{si} = \frac{C_{si} \times n_s \times V_s}{A_s}$$

where:

R_{si}	*is the emission rate in the standard room for the compound "i", µg/(m²⋅h) or mg/(m²⋅h)*
C_{si}	*is the concentration in the standard room of the compound "i", µg/m³ or mg/m³*
n_s	*is the air exchange rate in the standard room, h⁻¹*
V_s	*is the volume of the standard room, m³*
A_s	*is the building material's exposed area in the standard room, m²*

Furthermore, the definition is valid:

$R_{si} \cong R_{ki}$ *This approximately will to a great extent apply to e.g. most semi-hard materials*

Accordingly, the concentration of the indoor air quality can be calculated according to the formula below:

In cases where the influence of the air temperature, the relative humidity or other factors on the emission (and thereby the concentration) are known, this influence can be included in the technical assessment.

$$R_{si} = R_{ki}$$

$$\Downarrow$$

$$\frac{C_{si} \cdot n_s \cdot V_s}{A_s} = \frac{C_{ki} \cdot n_k \cdot V_k}{A_k}$$

$$\Downarrow$$

$$C_{si} = C_{ki} \cdot \frac{n_k}{n_s} \cdot \frac{L_s}{L_k}$$

Conversion of the results from the test chamber to indoor air quality is based on the following standard room and standard conditions (DSIC5):

Volume of the standard room:	17.4	m^3
Exposed areas in the standard room, m^2		
Flooring material		7
Ceiling material		7
Wall coating		24
Door surface		2
Window frame	0.2	
Sealants	0.2	
Fixtures	4	
Total		44.4 m^2

When the conditions in the test chamber do not vary significantly from the requirements to the climate parametres of the standard room, the results can be used without correction.

All materials can have the same emission per m².

Calculation of the Indoor-Relevant Time-Value Based on Chemical Analyses

The databank "VOCBASE", includes odour thresholds, OT, and irritation thresholds, IT, (DSIC4).

The acceptable concentration in the indoor air quality of one individual compound is 50% of

the smallest of the values OT and IT. The acceptable concentration is calculated from the formula below:

$C_{Li} = 0.5 \cdot \min \{OT, IT\}_i$

where

C_{Li}	*is the acceptable concentration of the indoor air quality of the compound "i", µg/m³ or mg/m³*
OT	*is the odour threshold, µg/m³ or mg/m³*
IT	*is the irritation threshold, µg/m³ or mg/m³*

It is assumed that the irritative impact from more compounds at the same time is bigger than the irritative impact from an individual compound. When there are more compounds, which is often the case, the requirement to the concentration is made on the level of a sum of compounds and not on the level of one single compound, see the formula below. The sum formula does not apply in the case of odour.

$$\sum_{i=1}^{x} \frac{C_{si}}{C_{Li}} < 1$$

The measured indoor-relevant time-value is given in whole days.

Evaluation of Sensory Determination

The sensory determination is used as a total and supplementary determination of the air quality. The sensory evaluation of the acceptability and intensity of the air is generally carried out at the time corresponding to the time-value based on chemical testing.

The sense of smell has receptors which are sensitive both qualitatively and quantitatively to a large number of chemical compounds. By determination the quality is referring to acceptability and the quantity is referring to the intensity.

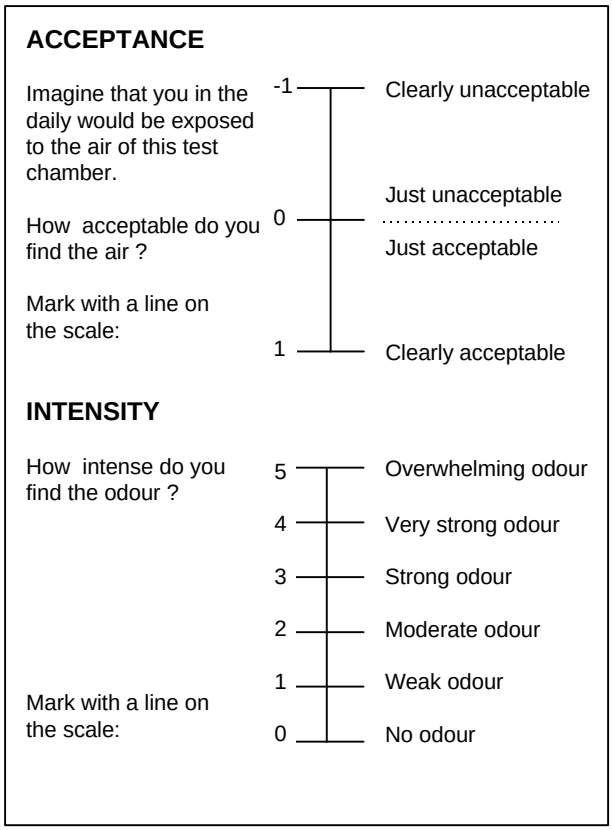
The objective of the test is to make a sensory determination of the total emission from building products in a test chamber. The principle is that the building products in the test chamber are exposed in a constant climate corresponding to the climate in living rooms in buildings and that a representative number of test persons at specific times determine the exhaust air from the test chamber according to a given procedure.

The test chamber should be equipped with an odour diffuser allowing sensory evaluations by sniffing.

For determination an untrained panel consisting of approx. 20 persons is used. The composition of the persons in the panel should reflect the composition of persons in the society, especially, what concerns sex and smoking habits, which is assumed to influence the determination. It should be avoided to use persons, who have been working a in a strongly smelling environment. Furthermore, the persons should have the sense of smell and should not have a cold. There should be an equal distribution of sexes.
The panellists should be between 18 and 50 years of age and it should be noted whether the

members of the panel are smokers or not. The persons in the panel must not emit disturbing smells and the person in charge of the test should control this. The persons must not eat nor smoke the last hour prior to the determination.

The panellists indicate their evaluations on two continuous scales regarding intensity and acceptability of the air compared to reference air:



An acceptability of A0@ (just acceptable) and an odour intensity of A2@ (moderate odour) can be used as the limits for acceptable air quality.

DSIC References:

1. Danish Indoor Climate Labelling. Standard Test Method for Determination of Emission from Building Products (in Danish). Danish Indoor Climate Labelling Association, 1.st edition December 1994.

2. Wolkoff, P. and Nielsen, P.A. Indoor Climate Labelling of Building Materials: The Experimental Approach for a Prototype, *Characterizing Sources of Indoor Air Pollution and Related Sink Effects, ASTM STP 1287,* American Society for Testing and Materials, 1996, pp. 331-349.

3. Wolkoff, P. and Nielsen, P.A. A New Approach for Indoor Climate Labelling of Building Materials - Emission Testing, Modelling and Comfort Evaluation *Atmospheric Environments*, Vol. 30, 1996. pp. 2679-2689.

4. Jensen, B. and Wolkoff, P. VOCBASE. Odour Thresholds, Mucous Membrane Irritation Thresholds and Physio-Chemical Parameters of Volatile Organic Compounds. Nat. Inst. Occup. Health. Denmark. 1996

5. Directions for the Determination and Evaluation of the Emission from Building Products. DS/INF 90 (in Danish). Danish Standards Association. Copenhagen 1994.

6. Nielsen, P.A., Jensen, L.K., Eng, K., Bastholm, P., Hugod, C., Husemoen, T., Mølhave, L. and Wolkoff, P.: Health-Related Evaluations of Building Products Based on Climate Chamber Tests, Indoor Air, Vol. 4, pp. 146-153, 1994.

Appendix 5
All Chemicals List
and
Project Specific List

List of Contents

Appendix 5
All Chemicals List

The All Chemicals List covers substances with carcinogenic, reprotoxic, allergen or neurotoxic effects, which in principle could be expected to be emitted from wood and wood-based materials.

The all chemicals list refers to the following data:

Chemical identity:

- CAS-number
- Name of chemical substance
- Type of chemical substance
- Vapour pressure at 25EC [VP mmHg], reference: Danish Environmental Protection Agency (file of calculated values, dated 1996.08.23).

Health and comfort effects:

- Carcinogenicity [C].

  References: Substances considered Acarcinogenic@ according to Lists on Threshold Limit Values for Chemical Substances in the Working Environment in Denmark (see below).

- Reproductive toxicity [R].

  Reference: Reproductive toxicants in the work environment, National Institute of Occupational Health, AMI-report No.35/1991.

  1L = considered a reproductive toxicant at low dose
  1M = considered a reproductive toxicant at medium dose
  1H = considered a reproductive toxicant at high dose
  2M = considered a suspected reproductive toxicant at medium dose
  2H = considered a suspected reproductive toxicant at high dose
  3 = the chemical cannot be evaluated as to its reproductive toxicity.

- Allergy [A].

  Reference: Allergens in the working environment, National Insitute of Occupational Health, AMI-Report No. 33/1990.

  L= Airway allergens
  S= Contact allergens

- Neurotoxicity [N].

  Reference: Neurotoxic substances in the work environment, Danish Working Environment Service, At-report Nr. 13/1990.

SRI-1 = Substances causing minor risks of health effects by accident and intensive exposure. Usual work with the substance does not cause any risk
SRI-2 = Substances causing minor risks of health effects by usual work
SRI-3 = Substances causing risk of health effects by usual work by skin contact and by respiration of spray haze
SRI-4 = Substances causing major risks of permanent and/or serious damages on the nervous system even by usual work with the substances
SRI-5 = Substances causing a major risk of unconsciousness, death or serious damages on the nervous system by usual work

· Classification.

Reference: List of dangerous substances. Ministry of Environment and Energy. Order no. 69, February, 1996.

C Corrosive
E Explosive
F Highly flammable
Fx Extremely flammable
N Dangerous for the environment
O Oxidizing
T Toxic
XI Irritant
XN Harmful

Carc1 Carcinogenic Carc1 (Labelling: AToxic@)
Carc2 Carcinogenic Carc2 (Labelling: AToxic@)
Carc3 Carcinogenic Carc3 (Labelling: AHarmful@)
Mut2 Mutagenic Mut2 (Labelling: AToxic@)
Mut3 Mutagenic Mut3 (Labelling: AHarmful@)
Rep2 Substances toxic to reproduction Rep2:
- substances should be regarded as if they impair fertility in humans
- substances which should be regarded as if they cause developmental toxicity in humans.

R2 Risk of explosion by shock, friction, fire or other sources of ignition
R7 May cause fire
R10 Flammable
R11 Highly flammable
R12 Extremely flammable
R19 May form explosive peroxides
R20 Harmful by inhalation
R21 Harmful in contact with skin
R22 Harmful if swallowed
R23 Toxic by inhalation
R24 Toxic in contact with skin
R25 Toxic if swallowed
R26 Very toxic by inhalation
R33 Danger of cumulative effects

R34 Causes burns
R36 Irritating to eyes
R37 Irritating to respiratory system
R38 Irritating to skin
R40 Possible risks of irrevesible effects
R41 Risk of serious damages to eyes
R42 May cause sensitization by inhalation
R43 May cause sensitization by skin contact
R45 May cause cancer
R46 May cause heritable genetic damage
R48 Danger of serious damage to health by prolonged exposure
R50 Very toxic to aquatic organisms
R51 Toxic to aquatic organisms
R52 Harmful to aquatic organisms
R53 May cause long-term adverse effects in the aquatic environment
R59 Dangerous for the ozone layer
R60 May impair fertility
R61 May cause harm to the unborn child

· Threshold Limit Values for Chemical Substances in the Work Environment [TLV]. Reference: At-anvisning Nr. 3.1.0.2, 1994, and update December 1996.

· C-values.

Reference: Industrial Air Pollution Control Guidelines, Danish Environmental Protection Agency 1992. Most values are obtained from file, dated 1996.11.21,

* indicates values obtained from an earlier file.

Appendix 5
Project Specific List

The Project Specific List covers substances quantified by the emission chamber measurements of the selected examples of wood and wood-based materials investigated in this project.

The product specific list refers to the following data:

Chemical identity:

- CAS-number
- Name of chemical substance
- Type of chemical substance
- Vapour pressure at 25EC [VP mmHg], reference: Danish Environmental Protection Agency (file of calculated values, dated 1996.08.23).

Health and comfort effects:

- Carcinogenicity [C].

  References: Substances considered Acarcinogenic@ according to Lists on Threshold Limit Values for Chemical Substances in the Working Environment in Denmark (see below).

- Reproductive toxicity [R].

  Reference: Reproductive toxicants in the work environment, National Institute of Occupational Health, AMI-report No.35/1991.

  1M = considered a reproductive toxicant at medium dose
  2M = considered a suspected reproductive toxicant at medium dose
  2H = considered a suspected reproductive toxicant at high dose
  3 = the chemical cannot be evaluated as to its reproductive toxicity.

- Allergy [A].

  Reference: Allergens in the working environment, National Insitute of Occupational Health, AMI-Report No. 33/1990.

  L= Airway allergens
  S= Contact allergens

- Neurotoxicity [N].

  Reference: Neurotoxic substances in the work environment, Danish Working Environment Service, At-report Nr. 13/1990.

  SRI-1 = Substances causing minor risks of health effects by accident and

intensive exposure. Usual work with the substance does not cause any risk

SRI-2 = Substances causing minor risks of health effects by usual work

SRI-3 = Substances causing risk of health effects by usual work by skin contact and by respiration of spray haze

SRI-4 = Substances causing major risks of permanent and/or serious damages on the nervous system even by usual work with the substances

SRI-5 = Substances causing a major risk of unconsciousness, death or serious damages on the nervous system by usual work

· Classification.

Reference: List of dangerous substances. Ministry of Environment and Energy. Order no. 69, February, 1996.

C	Corrosive
F	Highly flammable
Fx	Extremely flammable
T	Toxic
XI	Irritant
XN	Harmful
Carc3	Carcinogenic Carc3 (Labelling: AHarmful@)
Rep2	Substances toxic to reproduction Rep2:
-	Substances should be regarded as if they impair fertility in humans
-	Substances which should be regarded as if they cause developmental toxicity in humans.
R10	Flammable
R11	Highly flammable
R12	Extremely flammable
R20	Harmful by inhalation
R21	Harmful in contact with skin
R22	Harmful if swallowed
R23	Toxic by inhalation
R24	Toxic in contact with skin
R25	Toxic if swallowed
R26	Very toxic by inhalation
R34	Causes burns
R36	Irritating to eyes
R37	Irritating to respiratory system
R38	Irritating to skin
R40	Possible risks of irrevesible effects
R43	May cause sensitization by skin contact
R60	May impair fertility
R61	May cause harm to the unborn child

· Threshold Limit Values for Chemical Substances in the Work Environment [TLV]. Reference: At-anvisning Nr. 3.1.0.2, 1994, and update December 1996.

· C-values.

Reference: Industrial Air Pollution Control Guidelines, Danish Environmental Protection Agency 1992. Most values are obtained from file, dated 1996.11.21, * indicates values obtained from an earlier file.

· Odour Threshold Values [Odour].

References: VOCBASE, AMI, 1996. * indicate values from Boholt.K. internal report for the Danish Environmental Protection Agency [*], 1992.

· Irritation threshold values for the indoor air [Irritation threshold]

The irritation threshold is based on respiratory decrease in mice: RD50-values. Irritation threshold values of the indoor air take exposure 24 hours a day and 7 days a week and a safety factor of 10 to protect sensitive groups of population into account: 0.03/40xRD50. (Nielsen, G. D. and Peder Wolkoff, National Institute of Occupational Health, Denmark, 1997).

Reference for RD50-values: VOCBASE, 1996.

· Comfort and health effect of concern [LCI-EFF] covers:

C	=	Carcinogenicity
R	=	Reproductive toxicity
A	=	Allergy
N	=	Neurotoxicity
I	=	Irritation

[?] express doubts about a given effect.

The effects are based on hazard assessments. However considered the relative low concentrations of the chemical substances in the indoor environment the substances are characterizied by mainly irritative effects.

The background of the LCI-effects is given in Chapter 4 & 5 and Appendix 7.

· Lowest Concentration of Interest in the indoor air [LCI Wood].

Background of LCI Wood values is given in Chapter 4 & 5 and Appendix 7.

Other abbreviations used:

[Un]	Unknown
[nv]	No value.
(#)	n-Propylbenzene - 1,3,5 Trimethylbenzene.

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³	Odour µg/m³	Irritation threshold µg/m³	LCI Wood µg/m³	LCI EFF
107-92-6	Butanoic acid	acids	2,18					C;R34		0,0001	15	780	780	I
109-52-4	Pentanoic acid	acids	0,83					C;R34			20	nv	780	
71-36-3	Butanol	alcohols aliphatic	16,3					R10 XN;R20	150	0,2	90	8900	200	I
111-70-6	1-Heptanol	alcohols aliphatic								1	120	360	1000	N?/I?
78-83-1	2-Methyl-1-propanol	alcohols aliphatic							150	0,4	2600	4200	400	N/I
71-41-0	1-Pentanol	alcohols aliphatic							360		20	4300	4300	I
584-02-1	3-Pentanol	alcohols aliphatic							360		nv	nv	4300	I
3319-86-4	1-Octen-3-ol	alcohols aliphatic unsat.									16	nv	16	
100-51-6	Benzyl alcohol	alcohols aromatic	0,36			S		XN;R20/22		0,1	25000	nv	100	N/I
108-95-2	Phenol	alcohols aromatic	0,59				SRI-5	T;R24/25 C;R34	4	0,02	430	490	20	N/I
75-07-0	Acetaldehyde	aldehydes	740	K	2M		SRI-1	FX;R12 XI;R36/37 Carc3;R40	45	0,02	340	5200	5200	C/I
123-72-8	Butanal	aldehydes	89					F;R11		0,001	28	2800	2800	I
112-31-2	n-Decanal	aldehydes									6	nv	3100	
50-00-0	Formaldehyde	aldehydes	0,001	K	3	LS		T;R23/24/25 C;R34 Carc3;R40 R43	0,4	0,02	1100	3.8	100	C/I
111-71-7	Heptanal	aldehydes									23	nv	3100	
66-25-1	Hexanal	aldehydes									58	3400	3400	I
124-19-6	Nonanal	aldehydes									14	nv	3100	
124-13-0	Octanal	aldehydes									7	nv	3100	
110-62-3	Pentanal	aldehydes							175		22	3100	3100	I
123-38-6	Propanal	aldehydes	258					F;R11 XI;R36/37/38			14	4300	4300	I
107-02-8	Acrolein	aldehydes unsat.	221		2H	L		F;R11 T;R25 TX;R26 C;R34	0,25		410	3	3	C/I
100-52-7	Benzaldehyde	aldehydes unsat.	1,17					XN;R22			190	1200	1200	I
2497-25-8	2-Decenal	aldehydes unsat.									1	nv	2	
98-01-1	Furfural	aldehydes unsat.	2,38					T;R23/25	7,9	0,002	250	780	2	I/A
2463-63-0	2-Heptenal	aldehydes unsat.									28	nv	2	
2463-33-8	2-Nonenal	aldehydes unsat.									0.01	nv	2	
2363-89-5	2-Octenal	aldehydes unsat.									3.8	nv	2	
1576-87-0	2-Pentenal	aldehydes unsat.									690	nv	2	I
2463-77-6	2-Undecenal	aldehydes unsat.									4	nv	2	
140-11-4	Benzyl acetate	esters									910	nv	1100	I
123-86-4	Butyl acetate	esters	11,6				SRI-2	R10	710	0,1	47	2700	2700	I
109-21-7	Butyl butyrate	esters	2,08					R10			nv	nv	1100	
96-48-0	Butyrolactone	esters								un	nv	nv	un	
103-09-3	2-Ethyl hexyl acetate	esters									2300	nv	1100	
112-06-1	Heptyl acetate	esters									2000	nv	2000	
112-23-2	Heptyl formate	esters									nv	nv	1100	
110-19-0	Isobutylacetate	esters				S		F;R11	710	0,3	1700	3000	3000	I
638-49-3	Pentyl formate	esters	8,68					R10			nv	nv	1100	

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³	Odour µg/m³	Irritation threshold µg/m³	LCI Wood µg/m³	LCI EFF
112-34-5	2-(2-Butoxyethoxy)-ethanol	glycols, -ethers, -esters	0,02					XI;R36	100	0,02	9	nv	120	
5131-66-8	1-Butoxy-2-propanol	glycols, -ethers, -esters	1,05				SRI-3	XI;R36/38		0,4	381	nv	550	
15821-83-7	2-Butoxy-1-propanol	glycols, -ethers, -esters									nv	nv	550	
85409-76-3	1-Butoxy-2-propyl acetate	glycols, -ethers, -esters								0,1	nv	nv	550	
	2-Butoxy-1-propyl acetate	glycols, -ethers, -esters									nv	nv	550	
111-15-9	2-Ethoxy ethyl acetate	glycols, -ethers, -esters	3,09				SRI-3	Rep2;R60 Rep2;R61 XN;R20/21/22	27,0	0,1	447	3000	270	R
	2-Ethoxy hexyl acetate	glycols, -ethers, -esters									nv	nv	270	
108-65-6	1-Methoxy-2-propyl acetate	glycols, -ethers, -esters						R10 XI;R36	270	0,01	14	nv	600	R?
70657-70-4	2-Methoxy-1-propyl acetate	glycols, -ethers, -esters							110		nv	nv	600	R?
	Propylene glycol diacetate	glycols, -ethers, -esters									nv	nv	550	
25265-77-4	2,2,4-Trimethyl-1,3-pentanediol, monoiso-butyrate	glycols, -ethers, -esters									nv	nv	1000	
	Alkanes (C7-C12)	hydrocarbons aliphatic sat.								1*	4400	54500	20000	
	C4-Alkylbenzenes (tetra-methylbenzenes etc.)	hydrocarbons aromatic								0,1-0,4*	10-9700*	3000	550	
	C3-Alkylbenzenes	hydrocarbons aromatic							120	0,03	48-1150 #	5800-8500	500	
1330-20-7	C2-Alkylbenzenes (Xylenes, isomers)	hydrocarbons aromatic			1M		SRI-4	R10 XN;R20/21 XI;R38	109	0,1	78	?	100	
67-64-1	Acetone	ketones	197				SRI-2	F;R11	600	0,4	14000	77500	400	N/R/I
108-94-1	Cyclohexanone	ketones	3,09				SRI-4	R10 XN;R20	100	0,1	83	2300	2300	I
	2,9-Decane dione	ketones									nv	nv	un	
1129-58-9	Ethyl vinyl ketone	ketones									1.7	nv	2	
110-43-0	2-Heptanone	ketones	3,68					R10 XN;R22	230	0,1	680	3200	2300	
106-35-4	3-Heptanone	ketones	4,37				SRI-2	R10 XN;R20 XI;R36	230		nv	nv	2300	
821-55-6	2-Nonanone	ketones									230	nv	1900	
111-13-7	2-Octanone	ketones									91	1900	1900	I
	4-Octene-3-one	ketones									nv	nv	600	
	Formaldehyde butyl isobutyl-acetal	others (acetals)									nv	nv	20	
	Formaldehyde dibutylacetal	others (acetals)									nv	nv	20	
2568-91-4	Formaldehyde diisobutylacetal	others (acetals)									nv	nv	20	

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³	Odour µg/m³	Irritation threshold µg/m³	LCI Wood µg/m³	LCI EFF
5063-65-0	Pentyloxiran	others (ethers)									nv	nv	un	
78-67-1	2,2'-Azobisisobutyronitrile	others (nitrils)	0,01					E;R2 F;R11 XN;R20/22			nv	nv	un	
562-74-3	4-Terpineol	terpene alcohols									12000	nv	250	
98-55-5	alpha-Terpineol	terpene alcohols									240	nv	250	
1195-97-2	Limonene oxide	terpene epoxides									nv	nv	250	A
18309-32-5	Verbenone	terpene ketones									nv	nv	250	
68956-56-9	Terpenes, unidentified	terpenes				S			140		nv	nv	250	
79-92-5	Camphene	terpenes mono-									28000	nv	250	
4497-92-1	2-Carene	terpenes mono-									2500	nv	250	
13466-78-9	3-Carene	terpenes mono-									2500	nv	250	A
138-86-3	Limonene	terpenes mono-	0,72			S		R10 XI;R38			2500	nv	300	A
123-35-3	ß-Myrcene	terpenes mono-									140	nv	1700	R
99-83-2	"-Phellandrene	terpenes mono-									3400	nv	250	
80-56-8	"-Pinene	terpenes mono-				S				0,05	3900	nv	250	A
127-91-3	ß-Pinene	terpenes mono-									36000	nv	250	
99-86-5	"-Terpinene	terpenes mono-									2300	nv	250	A?
99-85-4	gamma-Terpinene	terpenes mono-									1500	nv	250	
80-57-9	Verbenone	terpenes mono-									nv	nv	250	
	Sesquiterpenes unidentified	terpenes sesqui-									nv	nv	250	A

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
85-44-9	Phthalic acid anhydride	acid anhydrides	<0,01			LS	SRI-1	XI;R36/37/38	1	0,001
75-98-9	2,2-Dimethylpropanoic acid	acids								
64-19-7	Acetic acid	acids	15,7					R10 C;R35	25	0,1
107-92-6	Butanoic acid	acids	2,18					C;R34		0,0001
64-18-6	Formic acid	acids	32					C;R35	9	0,003
111-14-8	Heptanoic acid	acids	0,16					C;R34		
57-10-3	Hexadecanoic acid	acids								
142-62-1	Hexanoic acid	acids								
79-31-2	Isobutyric acid	acids	3,37					XN;R21/22		
124-07-2	Octanoic acid	acids								
109-52-4	Pentanoic acid	acids	0,83					C;R34		
79-09-4	Propanoic acid	acids	5,91					C;R34	30	0,05
79-10-7	Acrylic acid	acids unsat.	5,91		2H	S		R10 C;R34	5,9	0,02
	1,1-Dimethyl allyl alcohol	alcohols aliphatic								
96-23-1	1,3-Dichloro-2-propanol	alcohols aliphatic	1,41	K				Carc2;R45 XN;R21 T;R25		
111-70-6	1-Heptanol	alcohols aliphatic								1
111-87-5	1-Octanol	alcohols aliphatic								
71-41-0	1-Pentanol	alcohols aliphatic							360	
104-76-7	2-Ethyl-1-hexanol	alcohols aliphatic								
78-83-1	2-Methyl-1-propanol	alcohols aliphatic							150	0,4
75-65-0	2-Methyl-2-propanol	alcohols aliphatic	62,7					F;R11 XN;R20	150	1
584-02-1	3-Pentanol	alcohols aliphatic							360	
107-18-6	Allyl alcohol	alcohols aliphatic	39,3				SRI-5	R10 T;R23/24/25 XI;R36/37/38 N;R50	5	0,01
71-36-3	Butanol	alcohols aliphatic	16,3					R10 XN;R20	150	0,2
108-93-0	Cyclohexanol	alcohols aliphatic	2,49		2M		SRI-4	XN;R20/22 XI;R37/38	200	0,05
123-42-2	Diacetone alcohol	alcohols aliphatic	2,18				SRI-2	F;R11 XI;R36	240	0,1
123-42-2	Diacetone alcohol	alcohols aliphatic	2,18				SRI-2	XI;R36	240	0,1
64-17-5	Ethanol	alcohols aliphatic	78,8		1L		SRI-1	F;R11	1900	5
111-27-3	Hexanol	alcohols aliphatic	2,96					XN;R22		
67-63-0	Isopropyl alcohol	alcohols aliphatic				S		F;R11	490	1
78-70-6	Linalool	alcohols aliphatic								
67-56-1	Methanol	alcohols aliphatic	138				SRI-5	F;R11 T;R23/25	260	0,3
25639-42-3	Methyl cyclohexanol (isomer)	alcohols aliphatic					SRI-2		235	
589-91-3	Methyl cyclohexanol (isomers)	alcohols aliphatic					SRI-2		235	
71-23-8	n-Propanol	alcohols aliphatic	37,7				SRI-3	F;R11	500	1
30899-19-5	Pentanol (isomers)	alcohols aliphatic					SRI-2	R10 XN;R20	360	
106-24-1	trans-Geraniol	alcohols aliphatic								
3319-86-4	1-Octen-3-ol	alcohols aliphatic unsat.								
128-37-0	2,6-Di-tert-butyl-4-methyl phenol	alcohols aromatic							10	0,01
100-51-6	Benzyl alcohol	alcohols aromatic	0,36			S		XN;R20/22		0,1
1319-77-3	Cresol (all isomers)	alcohols aromatic					SRI-5	T;R24/25 C;R34	22	0,003
87-86-5	Pentachloro phenol	alcohols aromatic	<0,01	K	1L		SRI-5	T;R24/25 TX;R26	0,05	0,00004

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
								Xi;R36/37/38 Carc3;R40 N;R50/53		
108-95-2	Phenol	alcohols aromatic	0,59				SRI-5	T;R24/25 C;R34	4	0,02
123-05-7	2-Ethyl hexanal	aldehydes								
96-17-3	2-Methyl butanal	aldehydes								
78-84-2	2-Methylpropanal	aldehydes								
590-86-3	3-Methyl butanal	aldehydes								
	4-Methyl hexanal	aldehydes								
75-07-0	Acetaldehyde	aldehydes	740	K	2M		SRI-1	F;R12 Xi;R36/37 Carc3;R40	45	0,02
123-72-8	Butanal	aldehydes	89					F;R11		0,001
	C9-Aldehyde, exept n-	aldehydes								
50-00-0	Formaldehyde	aldehydes	0,001	K	3	LS		T;R23/24/25 C;R34 Carc3;R40 R43	0,4	0,02
111-71-7	Heptanal	aldehydes								
66-25-1	Hexanal	aldehydes								
78-98-8	Methyl glyoxal	aldehydes								
112-31-2	n-Decanal	aldehydes								
124-19-6	Nonanal	aldehydes								
124-13-0	Octanal	aldehydes								
110-62-3	Pentanal	aldehydes							175	
123-38-6	Propanal	aldehydes	258					F;R11 Xi;R36/37/38		
123-73-9	2-Butenal	aldehydes unsat.	28,2				SRI-3	F;R11 T;R23 Xi;R36/37/38	6	0,02
	2-Butyl acrolein	aldehydes unsat.								
2497-25-8	2-Decenal	aldehydes unsat.								
2463-63-0	2-Heptenal	aldehydes unsat.								
	2-Heptylacrolein	aldehydes unsat.								
	2-Hexenal	aldehydes unsat.								
	2-Hexylacrolein	aldehydes unsat.								
78-85-3	2-Methyl acrolein	aldehydes unsat.								
2463-33-8	2-Nonenal	aldehydes unsat.								
2363-89-5	2-Octenal	aldehydes unsat.								
1576-87-0	2-Pentenal	aldehydes unsat.								
	2-Pentyl acrolein	aldehydes unsat.								
	2-Propyl acrolein	aldehydes unsat.								
2463-77-6	2-Undecenal	aldehydes unsat.								
107-02-8	Acrolein	aldehydes unsat.	221		2H	L		F;R11 T;R25 TX;R26 C;R34	0,25	
100-52-7	Benzaldehyde	aldehydes unsat.	1,17					Xn;R22		
98-01-1	Furfural	aldehydes unsat.	2,38					T;R23/25	7,9	0,002
60-35-5	Acetamide	amides	0,02					Carc3;R40		
68-12-2	N,N-Dimethyl formamide	amides	3,52	K	2M		SRI-4	Rep2;R61 Xn;R20/21 Xi;R36	30	0,1
123-39-7	N-Methyl formamide	amides			1M					
79-06-1	Acrylamide	amides unsat.	9	K	1L	S	SRI-5	Carc2;R45 Mut2;R46 T;R24/25-48/23/24/25	0,03	
51-75-2	2,2'-Dichloro n-methyl diethyl	amines		K						

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
	amine									
141-43-5	2-Amino ethanol	amines	1,61				SRI-3	XN;R20 XI;R36/37/38	2,5	0,01
108-01-0	2-Dimethyl amino ethanol	amines	7,97				SRI-2	R10 XI;R36/37/38		0,005
1336-21-6	Ammonia	amines						C;R34 XI;R37		
108-91-8	Cyclohexyl amine	amines	7,64				SRI-3	R10 XN;R21/22 C;R34	40	
111-42-2	Diethanol amine	amines	<0,01				SRI-1	XI;R36/38	2	0,01
109-89-7	Diethyl amine	amines	197				SRI-1	F;R11 XI;R36/37	15	0,02
108-18-9	Diisopropyl amine	amines				S	SRI-3	F;R11 XI;R36/37/38	20	
75-04-7	Ethyl amine	amines	1060			S	SRI-2	FX;R12 XI;R36/37	9,2	
107-15-3	Ethylene diamine	amines	17,1			LS	SRI-1	R10 XN;R21/22 C;R34 R43	25	
151-56-4	Ethylene imine	amines	189	K			SRI-5	Carc2;R45 Mut2;R46 F;R11 TX;R26/27/28 C;R34 N;R51	1	0,0001
100-97-0	Hexamethylenetetramine	amines				LS		F;R11 R42/43		
302-01-2	Hydrazine	amines		K		S	SRI-5	Carc2;R45 R10 T;R23/24/25 C;R34 R43	0,13	0,0002
74-89-5	Methyl amine	amines	2680			S		FX;R12 XI;R36/37	6,4	0,07
	N,N-Dimethyl-N-(1,1,1-tripropylmethyl) amine	amines								
872-50-4	N-Methyl-2-pyrrolidone	amines	0,41		2M		SRI-2	XI;R36/38	200	0,3
100-63-0	Phenyl hydrazine	amines	0,07				SRI-5	T;R23/24/25 XI;R36 N;R50	0,6	
121-44-8	Triethyl amine	amines	52,4		1H		SRI-3	F;R11 XI;R36/37	4,1	0,04
112-24-3	Triethylene tetramine	amines	0,02			LS		XN;R21 C;R34 R43 R52/53		
75-50-3	Trimethyl amine	amines				S		FX;R12 XI;R36/37	12	0,0002
66-71-7	1,10-Phenantroline	amines aromatic	9,88		3			T;R25		
91-94-1	3,3'-Dichloro benzidin	amines aromatic		K		S		Carc2;R45 XN;R21 R43 N;R50/53		
119-93-7	3,3'-Dimethylbenzidine	amines aromatic	0,15	K				Carc2;R45 XN;R22		
95-53-4	o-Toluidine	amines aromatic	0,45	K				Carc2;R45 T;R23/25 XI;R36	9	
110-86-1	Pyridine	amines aromatic	17,8					F;R11 XN;R20/21/22	15	0,07
71-55-6	1,1,1-Trichloro ethane	chlorinated hydrocarbons	96,4		2H		SRI-4	XN;R20 N;R59	275	0,5
79-34-5	1,1,2,2-Tetrachloro ethane	chlorinated hydrocarbons	4,57				SRI-4	TX;R26/27 N;R51/53	7	
79-00-5	1,1,2-Trichloro ethane	chlorinated hydrocarbons	18,6				SRI-4	XN;R20/21/22	54	
75-34-3	1,1-Dichloro ethane	chlorinated hydrocarbons	189				SRI-4	F;R11 XN;R22 XI;R36/37	400	
75-35-4	1,1-Dichloro ethylene	chlorinated hydrocarbons		K	1L		SRI-?	FX;R12 XN;R20-40	8	0,01
120-82-1	1,2,4-Trichloro benzene	chlorinated hydrocarbons					SRI-4		15	
120-82-1	1,2,4-Trichloro benzene	chlorinated hydrocarbons					SRI-4		40	
106-93-4	1,2-Dibromo ethane	chlorinated hydrocarbons		K			SRI-4	Carc2;R45 T;R23/24/25 XI;R36/37/38	1	0,0001
95-50-1	1,2-Dichloro benzene	chlorinated hydrocarbons	1,04			S	SRI-4	XN;R22 XI;R36/37/38 N;R50/53	150	0,1
107-06-2	1,2-Dichloro ethane	chlorinated hydrocarbons	67	K			SRI-4	Carc2;R45 F;R11 XN;R22 XI;R36/37/38	4	0,004
106-46-7	1,4-Dichloro benzene	chlorinated hydrocarbons	0,87	K		S	SRI-4	XN;R22 XI;R36/38	60	
764-41-0	1,4-Dichloro-2-butene	chlorinated hydrocarbons	3,23	K				Carc2;R45 T;R24/25 TX;R26	0,025	

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
								C;R34		
126-99-8	2-Chloro-1,3-butadiene	chlorinated hydrocarbons	175		1L		SRI-4	F;R11 XN;R20/22 XI;R36	3,6	
100-44-7	Benzyl chloride	chlorinated hydrocarbons	1,13	K				XN;R22 T;R23 XI;R37/38-41 Carc3;R40	5	0,0008
542-88-1	Bis(chloro methyl)ether	chlorinated hydrocarbons	28,2	K				Carc1;R45 R10 XN;R22 T;R24 TX;R26	0,005	
108-90-7	Chloro benzene	chlorinated hydrocarbons	8,68				SRI-4	R10 XN;R20	46	0,1
107-30-2	Chloro dimethyl ether	chlorinated hydrocarbons	65,5	K				Carc1;R45 F;R11 XN;R20/21/22		
74-87-3	Chloro methane	chlorinated hydrocarbons	4310	K			SRI-4	FX;R12 Carc3;R40 XN;R48/20	105	0,04
7572-29-4	Dichloro acetylene	chlorinated hydrocarbons		K				E;R2 Carc3;R40 XN;R48/20	0,4	
75-09-2	Dichloromethane	chlorinated hydrocarbons	364	K			SRI-4	Carc3;R40	122	0,02
118-74-1	Hexachloro benzene	chlorinated hydrocarbons	<0,01	K				Carc2;R45 T;R48/25		
87-68-3	Hexachloro butadiene	chlorinated hydrocarbons					SRI-4		0,24	
122-66-7	Hydrazo benzene	chlorinated hydrocarbons	2,08	K				Carc2;R45 XN;R22		
76-01-7	Pentachloro ethane	chlorinated hydrocarbons	2,49	K				Carc3;R40 T;R48/23 N;R51/53	40	
56-23-5	Tetrachloro methane	chlorinated hydrocarbons	85,5	K			SRI-5	T;R23/24/25-48/23 Carc3;R40 N;R59	6,3	
127-18-4	Tetrachloroethene	chlorinated hydrocarbons	13,8	K			SRI-4	Carc3;R40	70	0,01
79-01-6	Trichloro ethene	chlorinated hydrocarbons		K			SRI-4	Carc3;R40	55	0,04
67-66-3	Trichloro methane	chlorinated hydrocarbons	155	K			SRI-4	XN;R22-48/20/22 XI;R38 Carc3;R40	10	0,02
98-07-7	Trichloro methyl benzene	chlorinated hydrocarbons	0,18	K				Carc2;R45 XN;R22 T;R23 XI;R37/38-41		
75-01-4	Vinyl chloride	chlorinated hydrocarbons	2660	CAR 1	1L		SRI-5	Carc1;R45 FX;R12	3	0,002
	"Benzoate"	esters								
	"Cyclic acetate"	esters								
	"Ester of butyric acid"	esters								
	1-Ethyl hexyl propionate	esters								
	2-Butoxy-1-methylethyl propio-nate	esters								
103-09-3	2-Ethyl hexyl acetate	esters								
	2-Ethyl hexyl butyrate	esters								
547-63-7	2-Methyl propionic acid methyl ester	esters								
628-63-7	Amyl acetate (isomers)	esters	4,19				SRI-1	R10	266	0,02
140-11-4	Benzyl acetate	esters								
123-86-4	Butyl acetate	esters	11,6				SRI-2	R10	710	0,1
109-21-7	Butyl butyrate	esters	2,08					R10		
592-84-7	Butyl formate	esters	24,9					F;R11		
138-22-7	Butyl lactate	esters					SRI-1		25	0,1
623-42-7	Butyric acid methylester	esters								
96-48-0	Butyrolactone	esters								un
622-46-8	Carbamic acid phenylester	esters								

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
109-94-4	Ethyl formate	esters	213				SRI-1	F;R11	300	1
141-78-6	Ethylacetate	esters	85,5				SRI-2	F;R11	540	1
	Glycol propionate	esters								
112-06-1	Heptyl acetate	esters								
112-23-2	Heptyl formate	esters								
629-33-4	Hexyl formate	esters								
110-19-0	Isobutylacetate	esters				S		F;R11	710	0,3
108-21-4	Isopropylacetate	esters						F;R11	625	0,7
79-20-9	Methyl acetate	esters	189				SRI-2	F;R11	455	0,7
107-31-3	Methyl formate	esters	491				SRI-3	FX;R12	123	0,2
109-60-4	n-Propylacetate	esters	30,7				SRI-1	F;R11	625	0,1
112-32-3	Octyl formate	esters								
638-49-3	Pentyl formate	esters	8,68					R10		
	Phenyl lactic acid	esters								
	Alkyl-phtalates (saturated)	esters (phthalates)								
117-81-7	Di(2-ethylhexyl) phthalate	esters (phthalates)		K	1M				3	0,005
84-74-2	Dibutyl phthalate	esters (phthalates)			2H	S	SRI-2		3	0,01*
	Diethyl phthalate	esters (phthalates)								
131-11-3	Dimethyl phthalate	esters (phthalates)				S	SRI-2		3	0,01*
	Methylethyl phthalate	esters (phthalates)								
103-11-7	2-Ethyl hexyl acrylate	esters unsat.	0,23			S		XI;R37/38 R43		
818-61-1	2-Hydroxyethylacrylat	esters unsat.	5,38			S		T;R24 C;R34 R43	5	
868-77-9	2-Hydroxyethylmethacrylat	esters unsat.	127			S		XI;R36/38 R43		
141-32-2	Butyl acrylate	esters unsat.	4,98			S		R10 XI;R36/37/38 R43	11	0,006
97-88-1	Butyl methacrylate	esters unsat.	1,71		2H	S		R10 XI;R36/37/38 R43	145	
140-88-5	Ethyl acrylate	esters unsat.	29,5	K	2H	S		F;R11 XN;R20/21/22 XI;R36/37/38 R43	20	
97-63-2	Ethyl methacrylate	esters unsat.	36,1		2H	S		F;R11 XI;R36/37/38 R43	117	
97-90-5	Ethylene glycol dimethacrylate	esters unsat.	0,3			S		XI;R36/37		
25584-83-2	Hydroxypropyl acrylate	esters unsat.				S		T;R23/24/25 C;R34 R43		
97-86-9	Isobutyl methacrylate	esters unsat.	4,25		2H	S		R10 XI;R36/37/38 R43	290	
96-33-3	Methyl acrylate	esters unsat.	72,7			S		F;R11 XN;R20/22 XI;R36/37/38	35	0,002
80-62-6	Methyl methacrylate	esters unsat.	33,3		2M	LS	SRI-1	F;R11 XI;R36/37/38 R43	102	0,03
3524-68-3	Pentaerythritol triacrylate	esters unsat.	<0,01			S		XI;R36/38 R43		
1680-21-3	Triethylene glycol diacrylate	esters unsat.	<0,01			S		XI;R36/38 R43		
15625-89-5	Trimethylolpropane triacrylate	esters unsat.	<0,01			S		XI;R36/38 R43		
108-05-4	Vinyl acetate	esters unsat.	104				SRI-4	F;R11	30	0,2
534-15-6	1,1-Dimethoxy ethane	ethers	135					F;R11		
	Butoxy isobutoxy methane	ethers								
	Dibutoxymethane	ethers								
142-96-1	Dibutylether	ethers	5,42					R10 XI;R36/37/38		
	Diisobutoxymethane	ethers								
123-91-1	1,4-Dioxane	ethers cyclic	32	K	3	S		F;R11 R19 XI;R36/37	36	0,01-0,1

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
								Carc3;R40		
1464-53-5	Diepoxy butane	ethers cyclic	59,7	K		S		T;R23/24/25 XI;R36/37/38 XN;R40 R42/43		
106-89-8	Epichlorhydrin	ethers cyclic	15,7	K	1L	S	SRI-5	Carc2;R45 R10 T;R23/24/25 C;R34 R43	1,9	0,002
75-21-8	Ethylene oxide	ethers cyclic	1320	CAR 2	1L			Carc2;R45 Mut2;R46 FX;R12 T;R23 XI;R36/37/38	1,8	0,005
75-56-9	Propylene oxide	ethers cyclic	456	CAR 2		S		Carc2;R45 FX;R12 XN;R20/21/22 XI;R36/37/38	12	0,003
109-99-9	Tetrahydrofuran	ethers cyclic	132				SRI-3	F;R11 R19 XI;R36/37	295	0,2
	"Ethylene diglycol"	glycols								
5131-66-8	1-Butoxy-2-propanol	glycols, -ethers, -esters	1,05				SRI-3	XI;R36/38		0,4
85409-76-3	1-Butoxy-2-propyl acetate	glycols, -ethers, -esters								0,1
107-98-2	1-Methoxy-2-propanol	glycols, -ethers, -esters	12,4				SRI-2	R10	185	0,03
108-65-6	1-Methoxy-2-propyl acetate	glycols, -ethers, -esters						R10 XI;R36	270	0,01
6846-50-0	2,2,4-Trimethyl-1,3-pentanediol diisobutyrate, Kodaflex TXIB	glycols, -ethers, -esters								
25265-77-4	2,2,4-Trimethyl-1,3-pentanediol, monoiso-butyrate	glycols, -ethers, -esters								
112-34-5	2-(2-Butoxyethoxy)-ethanol	glycols, -ethers, -esters	0,02					XI;R36	100	0,02
15821-83-7	2-Butoxy-1-propanol	glycols, -ethers, -esters								
	2-Butoxy-1-propyl acetate	glycols, -ethers, -esters								
110-80-5	2-Ethoxy ethanol	glycols, -ethers, -esters	7,64		1M		SRI-3	Rep2;R60 Rep2;R61 R10 XN;R20/21/22	18,5	0,2
111-15-9	2-Ethoxy ethyl acetate	glycols, -ethers, -esters	3,09				SRI-3	Rep2;R60 Rep2;R61 XN;R20/21/22	27,0	0,1
	2-Ethoxy hexyl acetate	glycols, -ethers, -esters								
70657-70-4	2-Methoxy-1-propyl acetate	glycols, -ethers, -esters							110	
111-76-2	Butyl glycol	glycols, -ethers, -esters	1,61		3		SRI-3	XN;R20/21/22 XI;R37	120	0,04
110-71-4	Dimethoxy ethane	glycols, -ethers, -esters	69,8					R10 R19 XN;R20		
109-87-5	Dimethoxymethane	glycols, -ethers, -esters							3100	1
34590-94-8	Dipropylene glycol methylether	glycols, -ethers, -esters					SRI-1		300	1
109-86-4	Methyl glycol	glycols, -ethers, -esters	12,2		1L			Rep2;R60 Rep2;R61 R10 XN;R20/21/22	16	0,02
110-49-6	Methyl glycol acetate	glycols, -ethers, -esters	4,98					Rep2;R60 Rep2;R61 XN;R20/21/22	24	
57-55-6	Propylene glycol	glycols, -ethers, -esters				S				1
	Propylene glycol diacetate	glycols, -ethers, -esters								
	Diethylene glycol butyl ether acetate	glycols, ethers, esters								
30586-18-6	2,2,4,6,6-Pentamethylheptane	hydrocarbons aliphatic sat.								1*
62016-37-9	2,4,6-Trimethyloctane	hydrocarbons aliphatic sat.								1*
638-36-8	2,6,10,14-tetramethylhexadeca-ne	hydrocarbons aliphatic sat.								

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
78-78-4	2-Methylbutane	hydrocarbons aliphatic sat.						F;R11	1500	
591-76-4	2-Methylhexane	hydrocarbons aliphatic sat.								
871-83-0	2-Methylnonane	hydrocarbons aliphatic sat.								
3221-61-2	2-Methyloctane	hydrocarbons aliphatic sat.								
3777-69-3	2-Pentylfuran	hydrocarbons aliphatic sat.								
15869-93-9	3,5-Dimethyloctane	hydrocarbons aliphatic sat.								
15869-94-0	3,6-Dimethyloctane	hydrocarbons aliphatic sat.								
589-34-4	3-Methylhexane	hydrocarbons aliphatic sat.								
2216-33-3	3-Methyloctane	hydrocarbons aliphatic sat.								
96-14-0	3-Methylpentane	hydrocarbons aliphatic sat.								
	4,5-Diethylnonane	hydrocarbons aliphatic sat.								1*
2847-72-5	4-Methyldecane	hydrocarbons aliphatic sat.								1*
	Alkanes (C7-C12)	hydrocarbons aliphatic sat.								1*
106-97-8	Butane	hydrocarbons aliphatic sat.	1820					Carc2;R45 FX;R12	1200	
106-97-8	Butane	hydrocarbons aliphatic sat.	1820					FX;R12	1200	
	C10-Alkanes, exept n-	hydrocarbons aliphatic sat.								
	C10-Hydrocarbons with the exception of n-decane	hydrocarbons aliphatic sat.								
	C11-13 Alkanes	hydrocarbons aliphatic sat.								1*
	C11-Hydrocarbons	hydrocarbons aliphatic sat.								1*
	C12-Alkanes, exept n-	hydrocarbons aliphatic sat.								1*
	C12-Hydrocarbons	hydrocarbons aliphatic sat.								1*
	C16-Hydrocarbons	hydrocarbons aliphatic sat.								
	C18-Hydrocarbons	hydrocarbons aliphatic sat.								
3522-94-9	C9-Hydrocarbons	hydrocarbons aliphatic sat.								
	Hexane (branched chain or n-)	hydrocarbons aliphatic sat.								
	Hexane (other isomers than n-Hexan)	hydrocarbons aliphatic sat.					SRI-3			
	Isododecane	hydrocarbons aliphatic sat.								1*
124-18-5	n-Decane	hydrocarbons aliphatic sat.							250	
	n-Docosane C20	hydrocarbons aliphatic sat.								
112-40-3	n-Dodecane	hydrocarbons aliphatic sat.								1*
629-78-7	n-Heptadecane	hydrocarbons aliphatic sat.								
142-82-5	n-Heptane	hydrocarbons aliphatic sat.	36,2				SRI-3	F;R11	820	
544-76-3	n-Hexadecane	hydrocarbons aliphatic sat.								
110-54-3	n-Hexane	hydrocarbons aliphatic sat.	117				SRI-4	F;R11 XN;R48/20	90	0,4
111-84-2	n-Nonane	hydrocarbons aliphatic sat.					SRI-4		1050	
593-45-3	n-Octadecane	hydrocarbons aliphatic sat.								
111-65-9	n-Octane	hydrocarbons aliphatic sat.	11,2				SRI-4	F;R11	935	
629-62-9	n-Pentadecane	hydrocarbons aliphatic sat.								
64036-86-3	n-Tetradecane	hydrocarbons aliphatic sat.								
629-50-5	n-Tridecane	hydrocarbons aliphatic sat.								1*
1120-21-4	n-Undecane	hydrocarbons aliphatic sat.								1*
109-66-0	Pentane	hydrocarbons aliphatic sat.	423				SRI-2	F;R11	1500	

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
1921-70-6	Pristane	hydrocarbons aliphatic sat.								
629-20-9	1,3,5,7-Cyclooctatetraene	hydrocarbons aliphatic un-sat./cyclic								
106-99-0	1,3-Butadiene	hydrocarbons aliphatic un-sat./cyclic	2100	CAR 2	2H			Carc2;R45 FX;R12	22	
70688-47-0	1,4-Dimethyl cyclohexane	hydrocarbons aliphatic un-sat./cyclic								
	2-Butyl furan	hydrocarbons aliphatic un-sat./cyclic								
	2-Ethyl furan	hydrocarbons aliphatic un-sat./cyclic								
	2-Propyl furan	hydrocarbons aliphatic un-sat./cyclic								
100-40-3	4-Vinyl cyclohexene	hydrocarbons aliphatic un-sat./cyclic							0,4	
6069-98-3	cis-1-Methyl 4-methylethylcyclohexane cis/trans	hydrocarbons aliphatic un-sat./cyclic								
	Cyclodecane	hydrocarbons aliphatic un-sat./cyclic								
110-82-7	Cyclohexane	hydrocarbons aliphatic un-sat./cyclic	72,7				SRI-3	F;R11	172	1
	Cyclononanone	hydrocarbons aliphatic un-sat./cyclic								
	Cyclooctane	hydrocarbons aliphatic un-sat./cyclic								
542-92-7	Cyclopentadiene	hydrocarbons aliphatic un-sat./cyclic					SRI-2		200	
287-92-3	Cyclopentane	hydrocarbons aliphatic un-sat./cyclic	258				SRI-2	F;R11	850	
	Decene	hydrocarbons aliphatic un-sat./cyclic								
	Dimethyl cyclopentane	hydrocarbons aliphatic un-sat./cyclic								
	Ethylcyclohexane	hydrocarbons aliphatic un-sat./cyclic								
110-00-9	Furan	hydrocarbons aliphatic un-sat./cyclic								
592-76-7	Heptene	hydrocarbons aliphatic un-sat./cyclic								
108-87-2	Methyl cyclohexane	hydrocarbons aliphatic un-sat./cyclic	32				SRI-3	F;R11	805	1
534-22-5	Methyl furane	hydrocarbons aliphatic un-sat./cyclic								
109-67-1	Pentene	hydrocarbons aliphatic un-								

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
		sat./cyclic								
1678-82-6	trans-1-Methyl 4-methylethylcyclohexane cis/trans	hydrocarbons aliphatic un-sat./cyclic								
2437-56-1	Tridecene	hydrocarbons aliphatic un-sat./cyclic								1*
	Trimer 2-methyl propene	hydrocarbons aliphatic un-sat./cyclic								1*
526-73-8	1,2,3-Trimethylbenzene	hydrocarbons aromatic							120	0,03
95-93-2	1,2,4,5-Tetramethylbenzene	hydrocarbons aromatic								0,1-0,4*
95-63-6	1,2,4-Trimethylbenzene	hydrocarbons aromatic	1,76					R10 XN;R20 XI;R36/37/38	120	0,03
108-67-8	1,3,5-Trimethylbenzene	hydrocarbons aromatic	2,08					R10 XI;R37	120	0,03
99-62-7	1,3-Diisopropyl benzene	hydrocarbons aromatic								0,1-0,4*
100-18-5	1,4-Diisopropyl benzene	hydrocarbons aromatic								0,1-0,4*
1074-17-5	1-Methyl-2-propylbenzene	hydrocarbons aromatic								0,1-0,4*
1074-43-7	1-Methyl-3-propylbenzene	hydrocarbons aromatic								0,1-0,4*
637-50-3	1-Propenylbenzene	hydrocarbons aromatic								0,1-0,4*
611-14-3	2-Ethyl toluene	hydrocarbons aromatic								0,1-0,4*
777-22-0	2-Phenyl octane	hydrocarbons aromatic								
31017-40-0	4-Phenyl cyclohexene	hydrocarbons aromatic								0,1-0,4*
4537-11-5	5-Phenyl decane	hydrocarbons aromatic								
4537-15-9	5-Phenyl undecane	hydrocarbons aromatic								
98-83-9	"-Methylstyrene	hydrocarbons aromatic	2,08					R10 XI;R36/37	240	0,06
98-83-9	"-Methylstyrene	hydrocarbons aromatic	2,08					R10 XI;R36/37	240	0,1-0,4*
71-43-2	Benzene	hydrocarbons aromatic	75,7	CAR 1	1L		SRI-5	Carc1;R45 F;R11 T;R48/23/24/25	1,6	0,005
1330-20-7	C2-Alkylbenzenes (Xylenes, isomers)	hydrocarbons aromatic			1M		SRI-4	R10 XN;R20/21 XI;R38	109	0,1
	C3-Alkylbenzenes	hydrocarbons aromatic							120	0,03
	C4-Alkenyl benzene	hydrocarbons aromatic								0,1-0,4*
	C4-Alkylbenzenes (tetramethyl-benzenes etc.)	hydrocarbons aromatic								0,1-0,4*
	C5 Alkylbenzenes	hydrocarbons aromatic								
536-74-3	Ethynylbenzene	hydrocarbons aromatic								0,1-0,4*
98-82-8	Isopropyl benzene	hydrocarbons aromatic					SRI-4	R10 XI;R37	120	0,03
100-80-1	m-Methylstyrene m- and p-	hydrocarbons aromatic							120	0,1-0,4*
104-51-8	n-Butylbenzene	hydrocarbons aromatic								0,1-0,4*
91-20-3	Naphtalene	hydrocarbons aromatic							50	0,04
611-15-4	o-Methylstyrene	hydrocarbons aromatic	1,61					XN;R20	120	0,1-0,4*
95-47-6	o-Xylene	hydrocarbons aromatic	5,19				SRI-4		109	0,1
622-97-9	p-Methylstyrene	hydrocarbons aromatic							120	
103-65-1	Propyl benzene	hydrocarbons aromatic	2,72					R10 XI;R37		0,1-0,4*
100-42-5	Styrene	hydrocarbons aromatic	4,98	K	1M			R10 XN;R20 XI;R36/38	105	0,2
108-88-3	Toluene	hydrocarbons aromatic	21		1L		SRI-4	F;R11 XN;R20	94	0,4

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
	Trimethyl tetrahydro naphthale-none	hydrocarbons aromatic								
25551-13-7	Trimethylbenzene, mixed iso-mers	hydrocarbons aromatic					SRI-4		120	0,1-0,4*
25013-15-4	Vinyl toluene (all isomers)	hydrocarbons aromatic					SRI-5		120	0,1-0,4*
106-42-3	Xylene m- and p-	hydrocarbons aromatic					SRI-4		109	0,1
108-38-3	Xylenes, isomers	hydrocarbons aromatic					SRI-4		109	0,1
8008-20-6	Kerosene	hydrocarbons assorted					SRI-4	XN;R22		
8052-41-3	White spirit	hydrocarbons assorted		K	2M		SRI-4	Carc2;R45 R10 XN;R22-48/20	145	0,1
584-84-9	2,4-Diisocyanato toluene	isocyanates	0,01	K		LS		T;R23 XI;R36/37/38 R42	0,035	0,0002*
91-08-7	2,6-Diisocyanato toluene	isocyanates		K		LS		T;R23 XI;R36/37/38 R42	0,035	0,0002*
2536-05-2	Diphenylmethan-2,2'-diisocyanat	isocyanates				LS		XN;R20 XI;R36/37/38 R42		0,0002*
5873-54-1	Diphenylmethan-2,4'-diisocyanat	isocyanates				LS		XN;R20 XI;R36/37/38 R42		0,0002*
101-68-8	Diphenylmethan-4,4'-diisocyanat	isocyanates	4,67			LS		XN;R20 XI;R36/37/38 R42	0,05	0,0002*
9016-87-9	Diphenylmethandiisocyanat (isomers og homologs)	isocyanates				(LS)		XN;R20 XI;R36/37/38 R42		0,0002*
822-06-0	Hexamethylene-1,6-diisocyanate	isocyanates	0,04			LS		T;R23 XI;R36/37/38 R42/43	0,035	0,0002
4098-71-9	Isophorondiisocyanat	isocyanates	0,87			LS		T;R23 XI;R36/37/38 R42/43	0,045	0,0002*
	2-Methyl-3-pentanone	ketone								
	"Di-unsaturated" ketones	ketones								
	1,4-Dimethyl cyclohexenyl methylketon	ketones								
	2,8-Nonane dione	ketones								
	2,9-Decane dione	ketones								
	2-Ethoxy propiophenone	ketones								
110-43-0	2-Heptanone	ketones	3,68					R10 XN;R22	230	0,1
591-78-6	2-Hexanone	ketones	10,7		2H		SRI-4	F;R11 T;R48/23	4	
	2-Methyl isobutyl ketone	ketones								
583-60-8	2-Methylcyclohexanone	ketones	2,08				SRI-3	R10 XN;R20	230	
1120-72-5	2-Methylcyclopentanone	ketones								
821-55-6	2-Nonanone	ketones								
111-13-7	2-Octanone	ketones								
107-87-9	2-Pentanon	ketones							700	1
106-35-4	3-Heptanone	ketones	4,37				SRI-2	R10 XN;R20 XI;R36	230	
563-80-4	3-Methyl-2-butanon	ketones	42,7				SRI-3	F;R11	705	0,5
	4-Octene-3-one	ketones								
110-12-3	5-Methyl-2-hexanon	ketones	3,52				SRI-1	R10	230	0,005
541-85-5	5-Methyl-3-heptanone	ketones	1,56					R10 XI;R36/37	130	
6705-52-8	6-Oxabicyclo(3,1,0)hexane-2-one	ketones								

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
67-64-1	Acetone	ketones	197				SRI-2	F;R11	600	0,4
98-86-2	Acetophenone	ketones	0,41					XN;R22 XI;R36	49	0,01
123-54-6	Acetylacetone	ketones	5,91					R10 XN;R22		0,01
119-61-9	Benzophenone	ketones								
78-93-3	Butanone	ketones	75,7		2M		SRI-3	F;R11 XI;R36/37	145	1
108-94-1	Cyclohexanone	ketones	3,09				SRI-4	R10 XN;R20	100	0,1
120-92-3	Cyclopentanone	ketones	9,06					R10 XI;R36/38	90	0,1
693-54-9	Decanone	ketones								
431-03-8	Diacetyl	ketones								
108-83-8	Diisobutyl ketone	ketones	1,11				SRI-2	R10 XI;R37	150	0,06
1129-58-9	Ethyl vinyl ketone	ketones								
123-31-9	Hydroquinone	ketones	<0,01		2M	LS		XN;R20/22	2	
108-10-1	Methyl isobutyl ketone	ketones	16,3				SRI-1	F;R11	100	0,2
	Methyl vinyl ketone	ketones								
75-05-8	Acetonitrile	nitriles	69,8	CAR-2			SRI-5	F;R11 T;R23/24/25	70	0,1
	"Acrylate"	others								
2634-33-5	1,2-Benzisothiazol-3(2H)-one	others				S		XN;R22 XI;R38 R43		
96-29-7	2-Butanone oxime	others	3,68			S		XI;R36 R43		
	2-Ethyl-4-methyl-1,3-dioxolan	others								
422-91-8	2-Propylfuran	others								
1072-47-5	4-Methyl-1,3-dioxolane	others								
107-13-1	Acrylonitrile	others	85,5	K	1H	LS	SRI-5	Carc2;R45 F;R11 T;R23/24/25 XI;R38	4	0,002
107-05-1	Allyl chloride	others	279					F;R11 TX;R26 N;R50	3	0,002
94-36-0	Benzoyl peroxide	others	1,16			S		E;R2 O;R7 XI;R36 R43	5	
105-60-2	Caprolactam	others	0,65					XN;R20/22 XI;R36/37/38	1	0,005
105-60-2	Caprolactam	others	0,65					XN;R20/22 XI;R36/37/38	25	0,005
10605-21-7	Carbendazime	others			1M			Mut3;R40		
76-44-8	Heptachlor	others		K			SRI-4	T;R24/25 R33 Carc3;R40 N;R50/53	0,05	
95-13-6	Indene	others							45	
590-96-5	Methyl azoxy methanol	others		K						
107-19-7	Propargyl alcohol	others	18,6				SRI-5	R10 T;R23/24/25 C;R34	2,5	
1897-41-2	Tetrachloro terephthalonitrile	others						R43 R53		
1897-45-6	Tetrachloroisophthalonitrile	others	<0,01	K		S		Carc3;R40		
137-26-8	Tetramethyl-thiuramdisulfide	others	<0,01		1M	S		XN;R20/22 XI;R36/37 Mut3;R40 R43	1	
	Formaldehyde butyl isobutyl-acetal	others (acetals)								
	Formaldehyde dibutylacetal	others (acetals)								
2568-91-4	Formaldehyde diisobutylacetal	others (acetals)								
5063-65-0	Pentyloxiran	others (ethers)								
78-67-1	2,2'-Azobisisobutyronitrile	others (nitrils)	0,01					E;R2 F;R11 XN;R20/22		
562-74-3	4-Terpineol	terpene alcohols								

CAS-number	Chemical	Type of Compound	VP mmHg	C	R	A	N	Classification	TLV mg/m³	C-value mg/m³
98-55-5	alpha-Terpineol	terpene alcohols								
1195-97-2	Limonene oxide	terpene epoxides								
18309-32-5	Verbenone	terpene ketones								
	"-Campholene aldehyde	terpenes								
469-61-4	"-Cedrene	terpenes								
475-20-7	Longifolene	terpenes								
68956-56-9	Terpenes, uidentified	terpenes				S			140	
	Diterpenes unspecified	terpenes di-								
4695-62-9	d-Fenchone	terpenes mono								
115-95-7	Linalyl acetate, 1,6-Octadien-3-ol- 3,7-dimethyl acetate	terpenes mono								
4497-92-1	2-Carene	terpenes mono-								
13466-78-9	3-Carene	terpenes mono-								
99-83-2	"-Phellandrene	terpenes mono-								
80-56-8	"-Pinene	terpenes mono-				S				0,05
99-86-5	"-Terpinene	terpenes mono-								
507-70-0	Borneol	terpenes mono-								
79-92-5	Camphene	terpenes mono-								
76-22-2	Camphor	terpenes mono-				S			12	
99-85-4	gamma-Terpinene	terpenes mono-								
138-86-3	Limonene	terpenes mono-	0,72			S		R10 Xl;R38		
123-35-3	ß-Myrcene	terpenes mono-								
555-10-2	ß-Phellandrene	terpenes mono-								
127-91-3	ß-Pinene	terpenes mono-								
9005-50-7	Turpentine	terpenes mono-								
8006-64-2	Turpentine	terpenes mono-				S	SRI-4	R10 XN;R20/21/22	140	
80-57-9	Verbenone	terpenes mono-								
	Sesquiterpenes unidentified	terpenes sesqui-								
	Sesquiterpenone unidentified	terpenes sesqui-								
13877-93-5	trans-Caryophyllene	terpenes sesqui-								

Appendix 6
Results in Detail

Appendix 6
Emissions from Wood and Wood-Based Products - Results in Details

Results in details cover emissions quantified from the 23 kinds of solid wood and wood-based materials and products investigated by chamber testing.

List of Contents

Test Specimens

The tested materials and products cover products of varying complexicity including solid wood, wood-based boards, veneered particleboards, oil-treated solid beech and lacquered veneered particleboards.

The test specimens are briefly described below:

Solid wood

Solid wood is generally sampled by the sawmill after drying in their usual production line and forwarded to the testing laboratory. Upon receipt at the laboratory the test specimens were sampled and sealed in emission free plastic. The materials were stored frozen in order to avoid growth of mould and fungi.

B1 Ash, Danish origin. Planks: 132 x 25 mm
Moisture content approx. 9% according to supplier's information.
Moisture content approx. 11.1% and 8.7% at start and end of chamber testing respectively.

B2 Oak, German origin. Planks: 132 x 27 mm
Moisture content approx. 9% according to supplier's information.
Moisture content approx. 11.3% and 9.3% at start and end of chamber testing respectively.

B3 Beech, Danish origin. Planks: 132 x 25 mm
Moisture content approx. 9% according to supplier's information.
Moisture content approx. 13.8% and 9.3% at start and end of chamber testing respectively.

B4 Spruce, south Scandinavian origin. Planks: 135 x 40 mm
Moisture content approx. 9% according to supplier's information.
Moisture content approx. 11.1% and 8.7% at start and end of chamber testing respectively.

A13 Pine, Finnish origin. Heartwood share: approx. 84%
Moisture content approx. 17.0% and 10.4% at start and end of chamber testing respectively.

A14 Pine, Finnish origin. Sapwood share: approx. 96%
Moisture content approx. 14.0% and 9.9% at start and end of chamber testing respectively.

A15 Pine, Swedish origin. Heartwood share: approx. 67%
Moisture content approx. 15.9% and 9.6% at start and end of chamber testing respectively.

A16 Pine, Swedish origin. Sapwood share: approx. 98%
Moisture content approx. 17.5% and 10.1% at start and end of chamber testing

respectively.

Wood-based Panels

Wood-based panels are sampled by the supplier. Upon receipt at the laboratory the test specimens were sampled and sealed in emission free plastic.

C6 Particleboard of pine and spruce, MelamineUreaPhenolFormaldehyde (MUPF)-glue
Panels: 2000 x 1000 x 16 mm
Production week: 50, 1995. Receipt at laboratory week: 51, 1995.
Moisture content approx. 7.6% during chamber testing.

C7 Particleboard of pine and spruce, UreaFormaldehyde (UF)-glue
Panels: 2000 x 1000 x 16 mm
Production week: 50, 1995. Receipt at laboratory week: 51, 1995.
Moisture content approx. 6.7% and 7.4% at start and end of chamber testing respectively.

D8 Particleboard of pine and spruce, PolyUrethane (PU)-glue
Panels: 2700 x 1000 x 16 mm
Production week: 51, 1995. Receipt at laboratory week: 1, 1996.
Moisture content approx. 6.1% and 7.0% at start and end of chamber testing respectively.

D9 Birch Plywood, Phenol-glue
Panels: 2000 x 1000 x 15 mm
Production week: 4, 1996. Receipt at laboratory week: 5, 1996.
Moisture content approx. 9.3% and 8.7% at start and end of chamber testing respectively.

D10 Medium Density Fiberboard (MDF) of conifer, UreaFormaldehyde (UF)-glue
Panels: 500 x 500 x 15 mm
Production week: 4, 1996. Receipt at laboratory week: 8, 1996.
Moisture content approx. 5.1% and 5.3% at start and end of chamber testing respectively.

D17 Oriented Strand Board (OSB) of conifer, Phenol-glue
Panels: 2440 x 1220 x 15 mm
Production week: 8, 1996. Receipt at laboratory week: 25, 1996.
Moisture content approx. 6.1% during chamber testing.

Veneered particleboards

Particleboard UF-glue (C7) was used as basis for gluing on a 0.6 mm beech-veneer.

C11 Beech-veneered particleboard, PolyVinylAcetate (PVA)-glue for gluing-on veneer
Panels: 500 x 500 x 16 mm
Moisture content approx. 8.1% and 7.8% at start and end of chamber testing

respectively.

C12 Beech-veneered particleboard, UreaFormaldehyde (UF)-glue for gluing-on veneer
Panels: 500 x 500 x 16 mm
Moisture content approx. 6.4% and 7.4% at start and end of chamber testing respectively.

Oil-treated solid beech

Solid beech (B3) was used as basis for the oil-treatment.

F18 Urethane alkyd and linseed-oil based oil for floors on planed beech planks.
Application of oil according to supplier's information. Applied amount approx. 80 g/m².
Moisture content approx. 10.0% at the end of chamber testing.

F19 Natural resin and linseed-oil based oil for floors on planed beech planks.
Application of oil according to suppliers information. Applied amount approx. 84 g/m².
Moisture content approx. 10.4% at the end of chamber testing.

Lacquered veneered particleboards

Beech-veneered particleboard glued with ureaformaldehyde-glue (C12) was used as basis for the surface coatings. The application and drying of lacquer were made by the paint and varnish manufacturer using industrial equipment and procedures.

E20 Nitrocellulose lacquer on beech-veneered particleboard.
Spray application of 1 ground- and 1 top-coat of nitrocellulose lacquer was carried out 4 weeks before start of chamber testing. Applied amount in total approx. 200 g/m².
Moisture content approx. 7.9% at the end of chamber testing.

E21 UV-curing lacquer on beech-veneered particleboard.
Roll application of 2 ground- and 1 top-coat of UV-curing lacquer was carried out 4 weeks before start of chamber testing. Applied amount in total approx. 38 g/m².
Moisture content approx. 7.9% at the end of chamber testing.

E22 Acid-curing lacquer on beech-veneered particleboard.
Spray application of 1 ground- and 1 top-coat of acid-curing lacquer was carried out 4 weeks before start of chamber testing. Applied amount in total approx. 200 g/m².
Moisture content approx. 7.7% at the end of chamber testing.

E23 Water-based acrylic lacquer on beech-veneered particleboard.
Spray application of 1 ground- and 1 top-coat of acrylic lacquer was carried out 4 weeks before start of chamber testing. Applied amount in total approx. 200 g/m².

Moisture content approx. 8.0% at the end of chamber testing.

F24 Polyurethane lacquer on beech-veneered particleboard.
Spray application of 1 ground- and 1 top-coat of polyurethane lacquer was carried out 4 weeks before start of chamber testing. Applied amount in total approx. 200 g/m².
Moisture content approx. 7.7% at the end of chamber testing.

Results in Details - Chemical Analyses

The **lists of results in details** refer to the following data:

· Sample identification and description

The brief sample identifications and description refer to the test specimens described on the first pages of this Appendix.

· Testing procedure

The chamber testing was carried out according to the test method given in Appendix 3.

The test chambers used were made of stainless steel and had a volume of 225 litres. The tests were carried out at the standard test conditions of 45±5% relative humidity, 23±0.5EC and at a loading factor (L) and air exchange rate (n) ratio: n/L = 1. Refer to Appendix 3 for additional information.

Qualitative Screening

The qualitative screening has been carried out by headspace analysis. The material to be examined was placed in a diffusion tight bag with a relatively low amount of clean air and heated to 120EC for 1 hour. An air sample of 1 ml has been sampled with a gas tight syringe and analysed by head space capillary column gas chromatography combined with mass spectrometric detection (GC-MS).

Experimental conditions:

GC:

Capillary column:	35 m x 0.32 mm x 0.25 Fm CP-Sil 8CB (5% phenyl methylsilicone)
Injection method:	1 ml split at 250EC, split relation 1:5
Temperature programme:	0EC (1.0 min.), to 280EC with 15EC/min.
Carrier gas:	Helium, inlet pressure 5 psi

MS

Interface:	280EC
Detection:	Full scan m/z 25-400

Quantitative Analyses

The quantitative analyses have been carried out by collection of gases and vapours on adsorption tubes of charcoal and tenax and extracted by solvent desorption with carbon disulphide and dietyether respectively with isotop marked internal standard. The eluates were thereafter analyzed by GC-MS.

Experimental Conditions:

GC:
Capillary column: 50 m x 0.32 mm x 0.25 Fm CP-Sil 8CB
(5% phenyl methyl silicone)
MS:
Interface: 280EC
Detection: Full scan m/z 25-350

Tenax Tubes:
Injection: 2 Fl splitless at 250EC
Temperature programme: 20EC (3.0 min.), to 70EC with 10EC/min, to 300EC with 20EC/min, kept 5.0 min.
Carrier gas: Helium, constant flow 1.2 mil/min (3.1 psi at 20EC)

Coal Tubes:
Injection: 2 Fl splitless at 250EC
Temperature programme: 20EC (3.0 min.), to 70EC with 10EC/min, to 300EC with 20EC/min, kept 5.0 min.
Carrier gas: Helium, inlet pressure 5 psi

· Chemical identity of quantified substances

The chemical identity is given by name of chemical substance, type of chemical substance and CAS-number.

· Emission results in detail

All individual chemical substances quantified are included in the lists.

The measured AEmission rate@ and the @Calculated Standard Room Concentration@ are given to each of the 3 measurement times: 3-4 days, 9-11 days and 27-28 days respectively.

The standard room concentration was calculated for the area-interval 0.1 m^2 till 38 m^2 in a standard room with a volume of 17.4 m^3, covering a material-load interval from 0.006 to 2.2 m^2/m^3, to obtain a basis for toxicological considerations. It should, however, be noted that most of the tested materials and products are not commonly used over this large interval. Common material-load for untreated solid wood of ash, beech and oak; untreated wood-based panels; uncoated veneered wood-based panels and oil-treated solid wood for floors are approx. 0.4 m^2/m^3 or less.

A load of 2.2 m^2/m^3 can be seen for materials covering all surfaces of a room e.g. untreated solid wood of pine and spruce and for lacquered surfaces.

Calculation of Emissions

The principles for conversion of concentrations from test chamber to standard room

are gone through in Appendix 4-5, page 5. This results in:

$$C_{si} = C_{ki} \cdot \frac{n_k}{n_s} \cdot \frac{L_s}{L_k}$$

and

$$L_s = \frac{A_s}{V_s}$$

At chamber conditions with a material load $L_k = 1$ m²/m³ and an air exchange rate $n_k = 1$ h^{-1} the test chamber concentration is equal to the emission rates in the test chamber: $C_{ki} = R_{ki}$ ±

The concentration in the standard room can be calculated from:

$$C_{si} = R_{ki} \cdot \frac{A_s}{V_s \cdot n_s}$$

For $A_s = 0.1$ m² in $V_s = 17.42$ m³ standard room at an air exchange rate of $n_s = 0.5$ h^{-1}:

$$C_{si} = R_{ki} \cdot \frac{0.1}{17.42 \cdot 0.5} = R_{ki} \cdot 0.0115$$

For $A_s = 38$ m² in $V_s = 17.42$ m³ standard room at an air exchange rate of $n_s = 0.5$ h^{-1}:

$$C_{si} = R_{ki} \cdot \frac{38}{17.42 \cdot 0.5} = R_{ki} \cdot 4.3628$$

· Method of analyses:

SD-GCMS = Gas Chromatography with Mass Spectrometric detection.
SD indicates solvent desorption. Tenax and charcoal respectively indicate the collection media used.

DNPH-HPLC = High Pressure Liquid Chromatography for aldehydes by use of DiNitroPhenylHydrazine reagent tubes and acetonitrile extraction.

Acetylacetone-method = A photometric method for determination of especially formaldehyde based on Hartzsch reaction in which formaldehyde reacts with ammonium ions and acetylacetone. Determination by the acetylacetone-method is in accordance with the analytic procedure given in e.g. prEN 717-1:@Wood-based

panels. Determination of formaldehyde release. Part.1: Formaldehyde emission by the chamber method@.

· LCI-values

Lowest Concentration of Interest in the indoor air is estimated for each emitted chemical substance. The background for the LCI-values is given in Chapter 4 and 5 on principles for evaluation of the health and sensory effects of VOC emission from wood and wood-based products and in Appendix 7 on evalua-tion of single substances.

· Odour threshold

Odour threshold refers to odour threshold values given in the air quality databank, VOCBASE, 1996.

The results of the chemical analyses, expressed in emission rates [µg/m^{2}h] and calculated standard room concentrations of the individual chemical substances emitted, are given in the ***diagrams*** on the following pages.

The test results of the sensory determinations are given on the last pages of this Appendix.

Results in Details. Sensory Determinations

Directory sensory testing of odour perception has been carried out for spruce, beech veneered particleboard with by polyvinyl acetate glue and UV-curing lacquer on beech veneered particleboard by chamber testing (Danish Society of Indoor Climate. AStandard Test Method for Determination of Emission from Building Products@ 1994) in Climpaq-chamber with odour funnel diffuser allowing sensory evaluation by sniffing, see Appendix 4, part on AEvaluation of sensory determination@.

The determination was carried out to the time-value 1 day and with approx. 0.9 m^2 material load corresponding to approx. 0.12 m^2/ m^3 converted to the standard room of 17.4 m^3 (Danish Standard, DS/INF 90, 1994).

Sensory determination - Individual panel evaluation

Spruce		**Beech veneered particleboard with PVA-glue**		**UV-curing lacquer on beech veneered particleboard**	
Accepta-bility	**Intensity**	**Accepta-bility**	**Intensity**	**Accepta-bility**	**Intensity**
1.0	0.1	0.4	1.3	0.7	0.9
0.3	1.5	0.3	2.4	0.0	2.4
0.8	1.1	0.6	1.3	0.0	2.1
0.9	0.6	-0.1	1.1	0.8	0.7
0.0	1.2	0.1	2.3	1.0	0.6
0.8	1.3	-0.5	3.0	0.2	0.9
0.9	0.2	0.8	1.1	0.8	1.8
0.5	2.0	0.6	1.5	-1.0	4.0
0.9	0.1	0.8	0.5	0.0	3.1
0.3	2.1	0.4	1.9	0.9	0.5
0.3	2.2	0.5	2.0	-0.5	2.6
-0.2	1.9	0.1	1.8	1.0	0.1
0.8	1.0	-0.3	3.2	0.8	1.1
0.2	1.8	0.1	2.0	1.0	1.1
0.5	1.3	-0.1	3.0	0.7	0.9
-0.9	1.7	0.6	1.1	0.5	1.8
0.9	0.2	0.2	1.7	0.8	0.5
1.0	0.9	0.8	0.4	0.6	0.8
-0.3	1.3	0.3	1.3	0.7	0.7
				0.5	1.8
				0.2	1.9
				0.9	0.3

Result sensory testing	Spruce		Beech veneered particleboard with PVA-glue		UV-curing lacquer on beech veneered particleboard	
	Accept-ability	Intensity	Accepta-bility	Intensity	Accep-tability	Inten-sity
Specimen Median	0.5	1.3	0.3	1.7	0.7	1.0
Specimen Average	0.5	1.2	0.3	1.7	0.5	1.4
Reference Median	0.9	0.2	0.9	0.2	1.0	0.2
Reference Average	0.9	0.3	0.8	0.4	0.9	0.3

Results of sensory determination expressed as median and average.

Appendix 7
Evaluation
of Single Substances

Appendix 7
Evaluation of single substances

ACIDSACIDS

In general:
Organic acids cover a wide range of substances with a variety in the chemical structure. Organic acids are primary irritant and some cause severe tissue damage similar to those seen with strong mineral acids.

Butanoic acidButanoic acid CAS. no. 107-92-6

Acute toxicity	LD_{50} oral, rat: 2940 mg/kg LD_{50} dermal, rabbit: 530 mg/kg Severely irritant to eyes and skin in experimental animals.
Chronic toxicity	No information was available.
Human health effects	RD_{50} x 0.03/40 has been calculated to 0.78 mg/m; (VOCBASE, 1996).
Odour	Odour threshold value is reported to be 0.015 mg/m; (VOCBASE, 1996).
LCI	LCI-value: 0.78 mg/m; Justification: The LCI-value refers to sensory irritation.

Pentanoic acidPentanoic acid CAS. no. 109-52-4

Acute toxicity	LD_{50} oral, mouse: 600 mg/kg LC_{50} inhalation, mouse: 4100 mg/m;/h Corrosive to eyes, skin and mucous membranes in experimental animals.
Chronic toxicity	No information was available.
Odour	Odour threshold value is reported to be 0.02 mg/m; (VOCBASE, 1996).
LCI	LCI-value: 0.78 mg/m; Justification: The LCI-value is assumed analogical to Butanoic acid.

ALCOHOLSALCOHOLS

In general:
Alcohols are organic compounds characterized by rather low acute toxicity in single-dose oral toxicity experiments.

Repeated or prolonged exposure to alcohols may lead to depression of the central nervous system (narcotic action).

Alcohol vapours are characterized by their irritative properties in particular to the eyes but also to the mucous membranes of the respiratory tract.

In view of the widespread industrial use reports of severe adverse effects on humans are relatively few.

Aliphatic alcoholsAliphatic alcohols

1-Butanol-Butanol CAS. no.. 71-36-3

Acute toxicity

LD_{50} oral, mouse: 5200 mg/kg
LD_{50} dermal, rabbit: 3400 mg/kg
LC_{50} inhalation, rat: 24,000 mg/m;

Chronic toxicity

Inhalation study in rats for 4 months at concentrations of 0.8, 6.6 and 40 mg/m; showed, already after 30 days, effects on the central nervous system e.g. decrease in hexobarbital sleeping time and increase in reflex activity. Furthermore, other signs of toxicity were noted, e.g. increase in thyroid activity, increase in cholinesterase levels, dilatations of vessels and pulmonary edema.

Inhalation study in mice of 4 months- duration at a concentration 0.8, 6.6 and 40 mg/m; showed already after 30 days an increase in reflex activity.

Human health effects

Inhalation: The primary effects of exposure to vapours for short periods have varying degrees of irritation of the mucous membranes and central nervous system depression.

Vapour concentration of above 75 mg/m; produced mild irritation of nose, throat and eyes. At a vapour concentration of 150 mg/m; effects were more pronounced and associated with headache.

A 10-year study on workers indicated that systemic intoxication was unlikely when exposure was kept below 300 mg/m;, whereas slight headache, vertigo and drowsiness were noted. In some cases dermatitis on fingers or hands was seen.

Skin contact: Prolonged or repeated skin contact may produce dermatitis due to defatting action.

Eye contact: Irritation. Some people develop corneal inflammation associated with burning sensation.

RD_{50} x 0.03/40 has been calculated to 8.9 mg/m; (VOCBASE, 1996).

Odour Odour threshold value is reported to be 0.09 mg/m; (VOCBASE, 1996)

LCI LCI-value: 0.2 mg/m;
Justification: The LCI-value refers to irritation and corresponds to the C-value.

1-Heptanol-Heptanol CAS. no. 111-70-6

Acute toxicity LD_{50} oral, rat: 3250 mg/kg
LD_{50} oral, mouse: 1500 mg/kg
LD_{50} oral, rabbit: 750 mg/kg

Chronic toxicity No information was available.

Human health effects RD_{50} x 0.03/40 has been calculated to 0.36 mg/m; (VOCBASE, 1996).

Odour Odour threshold value is reported to be 0.12 mg/m; (VOCBASE, 1996).

LCI LCI-value: 1 mg/m;
Justification: The LCI-value refers to irritation and neurotoxicity and corresponds to the C-value.

2-Methyl-1-propanol-Methyl-1-propanol CAS. no. 78-83-1

Acute toxicity LD_{50} oral, rat: 2400 mg/kg

Chronic toxicity No information was available.

Human health effects Inhalation: Exposure to high concentration vapours caused vertigo, nausea, vomiting and headache with effects on hearing.

Skin contact: When applied for 15 minutes on hands of volunteers only slight irritation was seen. Causes defatting and dehydration on the skin.

Eye contact: Irritation, blurred vision and transient corneal va-cuoli zation.

	RD_{50} x 0.03/40 has been calculated to 4.2 mg/m; (VOCBASE, 1996).
Odour	Odour threshold value is reported to be 2.6 mg/m; (VOCBASE, 1996).
LCI	LCI-value: 0.4 mg/m; Justification: The LCI-value refers to irritation and neurotoxicity and corresponds to the C-value.

1-Octen-3-ol-Octen-3-ol CAS. no. 3391-86-4

Acute toxicity	LD_{50} oral, rat: 340 mg/kg LD_{50} skin, rabbit: 3300 mg/kg
Odour	Odour threshold value is reported to be 0.016 mg/m; (VOCBASE, 1996).
LCI	LCI-value: 0.016 mg/m; Justification: The LCI-value corresponds to the odour threshold value.

1-Pentanol-Pentanol CAS. no. 71-41-0

Acute toxicity	LD_{50} oral, rat: 3030 mg/kg LC_{lo} inhalation, rat: 14,000 mg/m;/6 hr
Chronic toxicity	No information was available.
Human health effects	Inhalation: Irritation of the nose and throat, headache, dizziness and drowsiness. Skin contact: Irritation. Prolonged skin contact may result in skin defatting and cracking. Eye contact: Stinging sensation and lachrymation. Furthermore, blurred vision and a burning sensation which may last for several days. RD_{50} x 0.03/40 has been calculated to 4.3 mg/m; (VOCBASE, 1996).
Odour	Odour threshold value is reported to be 0.02 mg/m; (VOCBASE, 1996).
LCI	LCI-value: 4.3 mg/m; Justification: The LCI-value refers sensory irritation.

3-Pentanol-Pentanol CAS. no. 584-02-1

Acute toxicity	LD_{50} oral, rat: 1870 mg/kg

Significant percutaneous absorption in experimental animals.

Chronic toxicity No information was available.

Human health effects Inhalation: Irritation of nose and throat, headache, dizziness and drowsiness. Burning sensation of the eyes.

Skin contact: Irritation. Prolonged exposure may result in skin defatting and cracking.

Eye contact: Stinging sensation and lachrymation. Furthermore, blurred vision and a burning sensation which may last for several days. Irritation from exposure to high concentrations.

RD_{50} x 0.03/40 has been calculated to 4.3 mg/m; for 1-pentanol. Although no data were available the expected sensory irritation may be of the same magnitude.

Odour Odour threshold value is not reported (VOCBASE, 1996).

LCI LCI-value: 4.3 mg/m;
Justification: The LCI is based on an assumption that the sensory irritation of 3-pentanol is comparable to those of 1-pentanol.

Aromatic alcoholsAromatic alcohols

Benzyl alcoholBenzyl alcohol CAS. no. 100-51-6

Acute toxicity LD_{50} oral, rat: 1230 mg/kg
LC_{50} inhalation, rat: 4420 mg/m;/8 hr

Chronic toxicity No information was available.

Human health effects Inhalation: Vapours containing high concentrations of benzyl alcohol together with several impurities e.g. benzene, cause temporary headache, vertigo nausea and loss of weight. Benzyl alcohol affects the central nervous system, in serious cases it may cause unconsciousness.
Skin contact: Irritation.
Eye contact: Irritation.

Odour Odour threshold value is reported to be 25 mg/m; (VOCBASE, 1996)

LCI LCI-value: 0.1 mg/m;
Justification: The LCI-value refers to irritation and neurotoxicity and corresponds to the C-value.

PhenolPhenol CAS. no. 108-95-2

Subacute toxicity	Rats exposed to vapours at a concentration of 100 mg/m; for 15 days showed excitement, twitching and depression. Dermal exposure of rabbits (dose of 250 mg/kg, 5 hours per day in 18 days) produced tremor, skin hyperaemia and hyperkeratosis.
Chronic toxicity	Inhalation study in rats for 3 months, at a concentration of 5 mg/m;. Toxic effects including damage of the liver function and chronaxie (increased nerve sensitivity to stimulation) were seen.
Human health effects	Inhalation: Phenol is a general poison with symptoms developing rapidly after 15-20 minutes. Liver and kidney damage after systemic absorption and a serious risk of unconsciousness, death or serious damage of the central nervous system. As symptoms from the central nervous system headache, dizziness, visual disturbances and weakness were seen. Intermitted exposure to vapour at a concentration of 185 mg/m; results in a marked nose and throat irritation. Skin contact: Severe skin burns. Repeated or prolonged contact with skin may cause dermatitis and darkening of skin. Exposure of eczematous skin to a solution of 2.5% phenol can cause coma within a few minutes. After prolonged exposure to a solution of low phenol concentration skin eruptions, nervous disorders and digestive disturbances were reported. Furthermore, fatalities were reported due to extensive liver and kidney damage. Eye contact: Marked irritation. Concentrated solutions cause severe irritation, and in some cases loss of vision was reported. There is no evidence that phenol acts as mutagen or specific carcinogen when humans are exposed to low concentrations. RD_{50} x 0.03/40 has been calculated to 0.49 mg/m; (VOCBASE, 1996).
Odour	Odour threshold value is reported to be 0.43 mg/m; (VOCBASE, 1996)
LCI	LCI-value: 0.020 mg/m; Justification: The LCI-value refers to irritation and corresponds to the C-value.

ALDEHYDESALDEHYDES

In general:
Aldehydes are volatile organic compounds characterized by their irritative properties. Aldehydes irritate skin, eyes and the upper respiratory system. Especially lower aliphatic aldehydes and unsaturated aliphatic aldehydes are irritant.

Minor amounts of aldehydes are quickly oxidized in the body to organic acids while they do not accumulate.

Saturated aldehydesSaturated aldehydes

AcetaldehydeAcetaldehyde CAS. no. 75-07-0

Acute toxicity
LD_{50} oral, rat: 1930 mg/kg. LD_{lo}, inhalation, rat: 7,200 mg/m;/4h.
LC_{50} inhalation, rat: 36,000 mg/m;/30 min
Application of acetaldehyde in hamster eyes results in eye injury, lacrimation and photophobia.

Chronic toxicity
Acetaldehyde causes genetic damage to somatic cells *in vivo*.
Increased incidence of tumours has been observed in inhalation studies on rats and hamsters exposed. In both animal species a tissue damage of the respiratory tract was seen. In rats, a dose-related increase in nasal adenocarcinomas and squamous cells carcinomas at doses of 1350 mg/m; and greater were reported.

Human health effects
Inhalation: Vapour at a concentration of 45 mg/m; did not induce any toxicological effects as shown in a study in volunteers whereas exposure vapours of 90 mg/m; caused a minor eye irritation.

RD_{50} x 0.03/40 has been calculated to 5.2 mg/m; (VOCBASE, 1996).

Skin contact: Repeated exposure may cause dermatitis and conjunctivitis.

Eye contact: Industrial exposure to the vapours results in irritation of the eyes and mucous membranes, headache and sore throat. Vapours at a higher concentration and extended exposure may injure the corneal epithelium, causing persistent lachrymation, photophobia and body sensation.

Odour
Odour threshold value is reported to be 0.34 mg/m; (VOCBASE, 1996).

LCI
LCI-value: 5.2 mg/m;
Justification: The LCI-value refers to sensory irritation.

ButanalButanal CAS. no. 123-72-8

Acute toxicity	LD_{50} oral, rat: 2940 mg/kg LD_{50} dermal, rabbit: 530 mg/kg Severe eye irritant and moderate to severe skin irritant in rabbits.
Chronic toxicity	No information was available.
Human health effects	RD_{50} x 0.03/40 has been calculated to 2.8 mg/m; (VOCBASE, 1996).
Odour	Odour threshold value is reported to be 0.028 mg/m; (VOCBASE, 1996).
LCI	LCI-value: 2.8 mg/m; Justification: The LCI-value refers sensory irritation.

DecanalDecanal CAS. no. 112-31-2

Acute toxicity	LD_{50} oral, rat: 3730 mg/kg LD_{50} dermal, rabbit: 5040 mg/kg Severe skin irritant in laboratory animals.
Chronic toxicity	No information was available.
Odour	Odour threshold value is reported to be 0.006 mg/m; (VOCBASE, 1996).
LCI	LCI-value: 3.1 mg/m; Justification: The LCI-value refers to the sensory irritation of saturated aldehydes and corresponds to the value of pentanal.

FormaldehydeFormaldehyde CAS. no. 50-00-0

Acute toxicity	LD_{50} oral, rat: 800 mg/kg LD_{50} inhalation, rat: 590 mg/m; TC_{lo} inhalation, man: 300 µg/m; (effects on nose and CNS)
Chronic toxicity	Formaldehyde in a long-term inhalation study carried out in rats causes squamous metaplasia of the nasal mucosa in two-third of the exposed animals. In one-third of animals, tumours of nasal cavity, mainly squamous-cell carcinoma were seen.
Human health effects	Inhalation: Exposure to vapours of low concentrations causes irritation of the respiratory tract, limited to upper respiratory airways only. Vapour concentrations of approximately 2.4 mg/m; cause slight

formication of the nose and pharynx.
At a higher concentration discomfort rapidly increases and lacrimation, olfactory changes, aggression and pulmonary changes were reported.

Asthmatic symptoms may occur due to allergic sensitivity, even at low concentrations as well as urticaria.

Skin contact: Sensitization, leading to allergic contact dermatitis is frequent.

Eye contact: Vapours at a concentration of 2.4 mg/m; cause slight formication, at higher concentrations burning of the eyes and severe lachrymation. Eye irritation is reported from at vapour concentrations from 0.6 to 0.06 mg/m;.

RD_{50} x 0.03/40 has been calculated to 0.0038 mg/m; (VOCBASE, 1996).

The World Health Organization has reassessed formaldehyde in 1996 and concluded: AThe lowest concentration which has been associated with nose and throat irritation in humans after short-term exposure is 0.1 mg/m;, although some individuals can sense the presence of formaldehyde at lower concentrations. To prevent significant sensory irritation in the general population, an air quality guideline value of 0.1 mg/m; as a 30 minute average is recommended. Since this guideline value of (0.1 mg/m;) is over one order of magnitude lower than a presumed threshold for cytotoxic damage to the nasal mucosa, this guideline value presents an exposure level at which there is negligible risk of upper respiratory tract cancer in humans.@ Larsen, J.C., Inst. for Toxicology, National Food Agency of Denmark, (Personal information), April 1997. Mølhave, L., Inst. of Environmental and Occupational Medicine, Aarhus University (Personal information).

The International Agency for Research on Cancer, IARC, has assessed the carcinogenic potential of formaldehyde and classified it as probably carcinogenic to humans (allocated to group 2A) on basis of certain evidence for carcinogenicity in experimental animals and limited evidence for humans. Cytotoxicity is considered to play an significant essential role in the carcinogenic effect of formaldehyde, and there is some genetic changes in the nasal mucosa of humans exposed to concentrations lower than 0.1 mg/m;. It is, therefore, probable that the concentration by lifelong exposure should be under 0.1 mg/m; as a yearly average to take adequate account for the carcinogenic effect.

The Danish Building Code contains requirements concerning formaldehyde emission from wood-based panels to secure that the form-

aldehyde concentration in the indoor air at realistic conditions for use does not exceed 0.15 mg/m;. (Building Code 1995, Ch. 11.3.2).

The Statutory Order from the Ministry of Environment, No. 289 of June 22, 1983, contains requirements concerning particle boards, plywood and similar panels for use in furniture, fixture and similar. These panels are only to be used if the equilibrium concentration of formaldehyde determined by chamber testing does not exceed the 0.15 mg/m; air. It should be noted that the requirements are given to the panels and not to the finished furniture in total and that the test conditions (material load and air exchange rate) corresponding to requirements in the Danish Building Code and statutory order from the Ministry of the Environment are different, and thus the results cannot be compared directly.

Odour Odour threshold value is reported to be 1.1 mg/m; (VOCBASE, 1996).

LCI LCI-value: 0.1 mg/m;

Justification: The LCI-value of 0.1 mg/m; refers to the 1996 evaluation for WHO Air Quality Guidelines.

HeptanalHeptanal CAS. no. 111-71-7

Acute toxicity LD_{50} oral, rat: 14 g/kg

Chronic toxicity No information was available.

Odour Odour threshold is reported to be 0.023 mg/m; (VOCBASE, 1996).

LCI LCI-value: 3.1 mg/m;
Justification: The LCI-value refers to the sensory irritation of saturated aldehydes and corresponds to the value of pentanal.

HexanalHexanal CAS. no. 66-25-1

Acute toxicity LD_{50} oral, rat: 4890 mg/kg
LC_{lo} inhalation, rat: 8195 mg/m;/4 hr (effects not given)
An irritant to skin and eyes of laboratory animals.

Chronic toxicity No information was available.

Human health effects RD_{50} x 0.03/40 has been calculated to 3.4 mg/m; (VOCBASE, 1996).

Odour Odour threshold value is reported to be 0.058 mg/m; (VOCBASE, 1996).

LCI LCI-value: 3.4 mg/m;
Justification: The LCI-value refers to sensory irritation.

NonanalNonanal CAS. no. 124-19-6

Acute toxicity Severe skin irritant.

Chronic toxicity No information was available.

Odour Odour threshold value is reported to be 0.014 mg/m; (VOCBASE, 1996).

LCI LCI-value: 3.1 mg/m;
Justification: The LCI-value refers to the sensory irritation of saturated aldehydes and corresponds to the value of pentanal.

OctanalOctanal CAS. no. 124-13-0

Acute toxicity LD_{50} oral, rat: 4622 mg/kg
LD_{50} dermal, rabbit: 5213 mg/kg

Chronic toxicity No information was available.

Odour Odour threshold value is reported to be 0.007 mg/m; (VOCBASE, 1996).

LCI LCI-value: 3.1 mg/m;
Justification: The LCI-value refers to the sensory irritation of saturated aldehydes and corresponds to the value of pentanal.

PentanalPentanal CAS. no. 110-62-3

Acute toxicity LD_{50} oral, rat: 3200 mg/kg
LD_{50} dermal, rabbit: 6000 mg/kg
LC_{lo} inhalation, rat: 14,000 mg/m;
Moderate skin irritant and severe eye irritant in rabbits.

Chronic toxicity No information was available.

Human health effects RD_{50} x 0.03/40 has been calculated to 3.1 mg/m; (VOCBASE, 1996).

Odour Odour threshold value is reported to be 0.022 mg/m; (VOCBASE,

1996).

LCI LCI-value: 3.1 mg/m;
Justification: The LCI-value refers to sensory irritation.

PropanalPropanal CAS. no. 123-38-6

Acute toxicity LD_{lo} oral, rat: 800 mg/kg
LD_{lo} dermal, rabbit: 3400 mg/kg
LC_{lo} inhalation, rat : 464,000 mg/m;
A skin irritant and severe eye irritant.

Chronic toxicity No information was available.

Human health effects RD_{50} x 0.03/40 has been calculated to 4.3 mg/m;(VOCBASE, 1996).

Odour Odour threshold value is reported to be 0.014 mg/m; (VOCBASE, 1996).

LCI LCI-value: 4.3 mg/m;
Justification: The LCI-value refers sensory irritation.

Unsaturated aldehydesUnsaturated aldehydes

AcroleinAcrolein CAS. no. 107-02-8

Acute toxicity LDLo oral, man: 10 mg/kg
TCLo inhalation, man: 2.3 mg/m; (irritation)

Chronic toxicity No long-term studies in rats and mice were carried out. A one year study in hamsters did not show an increased tumour incidence. Acrolein is genotoxic in *in vitro* and *in vivo* test systems.

Human health effects Inhalation: Exposure to vapour at a concentration of 2.3 mg/m;
causes lachrymation and marked eye, nose and throat irritation within 5 minutes. Severe pulmonary irritant and a higher concentration causes injury to lungs. Respiratory insufficiency may persist for at least 18 months. Delayed hypersensitivity was reported with a multiple organ involvement.

Considered a reproductive toxicant at high doses.

Skin contact: Corrosive.

Eye contact: Burning sensation in the eyes at low concentration vapours. Vapours violently irritant and lachrymation at high concentrations.

RD_{50} x 0.03/40 has been calculated to 0.003 mg/m; (VOCBASE, 1996).

Odour Odour threshold value is reported to be 0.410 mg/m; (VOCBASE, 1996).

LCI LCI-value: 0.003 mg/m;
Justification: The LCI-value refer to sensory irritation

BenzaldehydeBenzaldehyde CAS. no. 100-52-7

Acute toxicity LD_{50} oral, rat: 1300 mg/kg
Moderate skin and eye irritant.

Chronic toxicity No information was available.

Human health effects Inhalation: Workers chronically exposed to the vapours complained of headache, fatigue, itching of the throat, lachrymation, loss of sense of taste, numbness of the tongue and tremor. Symptoms usually disappeared rapidly after removal from the exposure.

Skin contact: Moderate skin irritant and skin sensitizer. Repeated exposure may cause irritant as well as allergic contact dermatitis.

Eye contact: Moderate eye irritation.

RD_{50} x 0.03/40 has been calculated to 1.2 mg/m; (VOCBASE, 1996).

Odour Odour threshold value is reported to be 0.190 mg/m; (VOCBASE, 1996).

LCI LCI-value: 1.2 mg/m;
Justification: The LCI-value refers to sensory irritation.

2-Decenal-Decenal CAS. no. 2497-25-8, cis-2-Decenal CAS no. ?, trans-2-Decenal CAS no. 3913-81-3

Acute toxicity

LD_{50} oral, rat: 5000 mg/kg
LD_{50} dermal, rabbit: 3400 mg/kg
Application of 500 mg/24h results in severe skin irritation.

Odour

Odour threshold value is reported to be 0.001 mg/m; for cis-2-decenal and 0.002 mg/m; for trans-2-decenal (VOCBASE, 1996).

LCI

LCI-value: 0.002 mg/m;
Justification: The LCI-value refers to the assumed irritation and allergy effects of unsaturated aldehydes and corresponds to the value of furfural.

FurfuralFurfural CAS. no. 98-01-1

Acute Toxicity

LD_{50} oral, rat: 65 mg/kg

Acute toxicity by inhalation in various laboratory animal species was moderate to high. Inhalation caused effects on several sites including liver, lungs, forestomach, kidney and the central nervous system. Inhalation caused nasal damage in hamsters.

Acute toxicity by the dermal route in rabbits was moderate. Furfural was irritant to the skin of rabbits and guinea pigs and caused damage to the eyes of rabbits.

Chronic toxicity

In oral long-term feeding studies in rats and in mice furfural gave evidence of liver, carcinogenicity, namely increased incidence of hepatochamberular adenomas and hepatocelular carcinomas. Furfural caused chromosome abnormalities in mice treated orally and in mammalian chambers in culture. Furfural was mutagenic in the mammalian chamber system, bacteria system and in the fruit fly.

Human health effects

Inhalation: Irritation and sensitization of the skin and mucous membranes of the eyes, nose and upper respiratory tract.

Chronic exposure to the vapours may develop headache, fatigue, itching of the throat, lachrymation, loss of the sense of taste, numbness of the tongue and tremor. Symptoms disappear rapidly after removal from exposure. Workers exposed to concentrations of 7.5-53 mg/m; for an indefinite period of time develop throat irritation and headache.

Skin contact: Sensitization, leading to allergic contact dermatitis and photosensitivity have been described.
Eye contact: Vapours at a concentration of approximately 50 mg/m; or

lower were reported to cause reddening of human eyes, tearing and irritation.

RD_{50} x 0.03/40 has been calculated to 0.78 mg/m; (VOCBASE, 1996).

Odour Odour threshold value is reported to be 0.25 mg/m; (VOCBASE, 1996).

LCI LCI-value: 0.002 mg/m;
Justification: The LCI-value refers to irritation and corresponds to the C-value.

2-Heptenal-Heptenal CAS. no. 2463-63-0, cis-2-Heptenal CAS. no. 57266-86-1, trans-2-Heptenal CAS. no.18829-55-5

Toxicity No information was available.

Odour Odour threshold value is reported to be 0.028 mg/m; for cis-2-heptenal and 0.063 mg/m; for trans-2-heptenal (VOCBASE, 1996).

LCI LCI-value: 0.002 mg/m;
Justification: The LCI-value refers to the assumed irritation and allergy effects of unsaturated aldehydes and corresponds to the value of furfural.

2-Nonenal-Nonenal CAS. no. 2463-33-8, cis-2-Nonenal CAS no. 60784-31-8, trans-2-Nonenal CAS. no. 18829-56-6,

Toxicity No toxicological information available.

Odour Odour threshold value is reported to be 0.00001 mg/m; for cis-2-nonenal and 0.001 mg/m; for trans-2-nonenal (VOCBASE, 1996).

LCI LCI-value: 0.002 mg/m;
Justification: The LCI-value refers to the assumed irritation and allergy effects of unsaturated aldehydes and corresponds to the value of furfural.

2-Octenal-Octenal CAS. no. 2363-89-5, cis-2-Octenal CAS no. 20664-46-4, trans-2-octenal CAS.no. 2548-87-0

Toxicity No information was available.

Odour Odour threshold value is reported to be 0.004 mg/m; for cis-2-octenal and 0.011 mg/m; for trans-2-octenal (VOCBASE, 1996).

LCI LCI-value: 0.002 mg/m;
Justification: The LCI-value refers to the assumed irritation and allergy

effects of unsaturated aldehydes and corresponds to the value of furfural.

2-Pentenal-Pentenal CAS. no. ?, trans-2-Pentenal CAS.no. 1576-87-0

Toxicity No toxicological information available.

Odour Odour threshold value is reported to be 0.69 mg/m; for trans-2-pentenal (VOCBASE, 1996).

LCI LCI-value: 0.002 mg/m;
Justification: The LCI-value refers to the assumed irritation and allergy effects of unsaturated aldehydes and corresponds to the value of furfural.

2-Undecenal-Undecenal CAS. no. 2463-77-6, cis-2-Undecenal CAS no. ?, trans-2-Undecenal Cas. no. 53448-07-0

Toxicity No information was available.

Odour Odour threshold is reported to be 0.012 mg/m; for cis-2-undecenal and 0.005 mg/m; for trans-2-undecenal (VOCBASE, 1996).

LCI The LCI-value: 0.002 mg/m;

Justification: The LCI-value refers to the assumed irritation and allergy effects of unsaturated aldehydes and corresponds to the value of furfural.

ESTERSESTERS

Benzyl acetateBenzyl acetate. CAS. no. 140-11-4

Acute toxicity LD_{50} oral, rats 2500 mg/kg and 830 mg/kg in mice.
Inhalation, mice: 1300 mg/m; (7-13 h) resulted in dyspnea, narcosis and death. Cats: 1103 mg/m; (8-9 h, 7 days) caused irritation, gradual weakness, loss of appetite and weight and drowsiness.

Chronic toxicity Gavage administration induces acinar cell adenomas in the pancreas of male rats. Benzyl acetate has been reviewed by IARC and in 1986 classified as Group 3 and by EPA, NTP Carcinogenesis Studies in 1986 (gavage): 'some evidence in mouse and rat' and in 1993 (feed): 'no evidence in mouse and rat'. In several in vitro and in vivo assays benzyl acetate was not mutagenic.

Human health effects The compound is described as moderate toxic. When ingested it can cause general intestinal irritation, and it also makes irritation to the eyes, skin and respiratory system. Slight throat irritation has been reported at 1000 mg/m; and nose irritation at 497 mg/m;.

Odour The odour threshold value is reported to be 0.91 mg/m; (VOCBASE, 1996).

LCI LCI-value: 1.1 mg/m;.
Justification: The LCI is based on an inhalation study on cats, where 1103 mg/m; caused irritative and other effects.
LCI = 'LOEL'/ SF^{I} x SF^{II} x SF^{III} = 1103/10 x 10 x 10 mg/m;= 1.1 mg/m;

Butyl acetateButyl acetate (all isomers). CAS. no. 123-86-4

Acute toxicity LD_{50} oral, rats, rabbits and mice 14100, 7400 and 7100 mg/kg body weight respectively.
LC_{50} inhalation, rats 9480 mg/m; (4 h). 14220 mg/m; (12 h) resulted in eye irritation in guinea pigs.

Chronic toxicity Butyl acetate did not induce lesions in mice or rats given in oral doses up to 2000 mg/kg (four weeks). No gross lesions were seen in rats receiving 600 mg/kg (oral) for 90 days. No teratogenic effects were found when rabbits and rats inhaled a concentration of
7110 mg/m;.
Negative results were reported when tested for the mutagenic potential. No studies on the carcinogenic potential have been found.

Human health effects The lowest concentration inducing an observable adverse effect in humans is 948 mg/m; (throat irritation) and 1422 mg/m; (nose and eye irritation). Observed effects on skin are fissures and degreasing. One case of contact allergy in man has been reported.
RD_{50} x 0.03/40 has been calculated to 2.7 mg/m; (VOCBASE, 1996).

Odour The odour threshold value is reported to be 0.047 mg/m; (VOCBASE, 1996).

LCI LCI-value: 2.7 mg/m;
Justification: Based on an inhalation study in humans, with a LOEL for throat irritation at 948 mg/m;.
LCI = LOEL/ SF^{I} x SF^{II} x SF^{III} = 948 mg/m;/ 1 x 10 x 10 = 9.50 mg/m;.

By using the RD_{50}-calculation the LCI is 2.7 mg/m;.
Because the C-value is based on an estimated odour threshold value, it does not correspond to the LCI-value.

Butyl butyrateButyl butyrate. CAS. no. 109-21-7

Acute toxicity LD_{50} oral, rabbits 9520 mg/kg. Butyl butyrate causes moderate irritation onto skin. Inhalation exposure of 26150 mg/m; (6 h) was lethal to two out of three rats. A lower dose of 2615 mg/m; for 6 hrs exposure produced no symptoms or death.

Chronic toxicity No data available

LCI LCI-value: 1.1 mg/m;
Justification: No adequate data for an assessment. The LCI is based on the LCI for benzyl acetate.

2-Ethylhexyl acetate-Ethylhexyl acetate. CAS. no. 103-09-3

Acute toxicity LD_{50} oral, rats 3 g/kg
The higher alkyl homologue of esters is described as relatively nontoxic (> 3 g/kg), causes mild to moderate irritation of the skin and eyes.

Chronic toxicity No data available

Odour The odour threshold value is reported to be 2.3 mg/m;

LCI LCI-value: 1.1 mg/m;
Justification: The LCI is based on the LCI for benzyl acetate.

Heptyl acetateHeptyl acetate. CAS. no. 112-06-1, 5921-82-4/5/6

Acute toxicity LD_{50} oral, rats > 5 g/kg. It is a mild skin irritant. The concentrated vapour inhaled by rats for 8 hrs proved to be non-lethal. Commercially, these acetates serve as a flavouring agents. Because of the high boiling point of this compound hazards from exposure to its vapours is quite remote.

Chronic toxicity No data available

Odour The odour threshold value is reported to be 2.0 mg/m;(VOCBASE, 1996).

LCI LCI-value: 2.0 mg/m;
Justification: No adequate data for an assessment of effects. The LCI is based on the odour threshold value 2.0 mg/m;, which is assumed to be below a concentration causing health effects of the compound.

Heptyl formateHeptyl formate. CAS. no. 112-23-2

Acute toxicity It is a primary irritant, moderate irritating onto skin. The allyl formates and the higher homologue appear to be much more toxic than their lower homologue and may cause hepatic damage. This may be due to the action of acrolein, one of its metabolic products. The formates are irritating to skin and mucous membranes including eyes and lungs. Ethyl formate caused eye irritation in humans at 1564 mg/m;.

Chronic toxicity No data available

LCI LCI-value: 1.1 mg/m;
Justification: No adequate data for an assessment. The LCI is based on the LCI for benzyl acetate.

Isobutyl acetateIsobutyl acetate. CAS. no. 110-19-0

Acute toxicity LD_{50} oral, rabbits 4800 mg/kg. Exposure to 18960 mg/m; for 4 hrs caused no death in rats. LC_{lo} inhalation, rats 37920 mg/m;. It is a mild-moderate skin and eye irritant.

Chronic toxicity No data available

Human health effect

Isobutyl acetate is relatively non-toxic in humans. Exposure to a concentration of 4500 mg/m; for 30 min caused irritation of the nose and eyes, headaches and weakness.

RD_{50} x 0.03/40 has been calculated to 3 mg/m; (VOCBASE, 1996).

Odour

The odour threshold value is reported to be 1.7 mg/m; (Woodfield, 1994).

LCI

LCI-value: 3.0 mg/m;
Justification: Based on an inhalation study on humans, with a LOEL for nose and eye irritation 4500 mg/m; .
LCI = LOEL/ SF^{I} x SF^{II} x SF^{III} = 4500 mg/m;/1 x 10 x 10 = 45 mg/m;

By using RD_{50} in the calculation the LCI is 3 mg/m;.
The C-value (0.3 mg/m;) is based on an odour threshold value and does not correspond to the LCI-value.

Pentyl formatePentyl formate. CAS. no. 638-49-3

Acute toxicity

LD_{50} oral, rats >5 g/kg. Mild irritant onto skin. Pentyl formate is an amyl formate. High concentrations by acute and chronic exposure may cause narcosis and low CNS effects.
The formates are irritating to skin and mucous membranes including eyes and lungs. Ethyl formate caused eye irritation in humans at 1564 mg/m;.

LCI

LCI-value: 1.1 mg/m;
Justification: No adequate data for an assessment. The LCI is based on the LCI for benzyl acetate, which is assumed to be below the probable irritative effects of pentyl formate.

GLYCOLS, -ETHERS, -ESTERSGLYCOLS, -ETHERS, -ESTERS

In general:
Glycol ether acetates have the same systematic toxicological effects as their parent glycol ethers and it is reasonable to consider that their toxicity is equivalent on a molar basis. The short chain ethylene glycol methyl and ethyl ethers and their acetates as well as other glycol ethers capable of being converted to ethylene glycol methyl or ethyl ethers, cause testicular atrophy, teratogenicity/foetotoxicity and bone marrow depression.

In contrast, longer chain ethylene glycol ethers (ethylene glycol butyl ether, -propyl ether,-isopropyl ether and -phenyl ether) do not cause these effects, but do cause erythrocyte fragility in rats. No testicular or bone marrow effects have been reported for the propylene glycol ethers, but teratogenic effects have been reported for 1-propylene glycol 2-methyl ether and the acetate.

The glycol ethers do not pose a genotoxic risk to man in valid test systems. The multitude of data on effects on man is compatible with experimental data in several animal species.

In most studies on glycol-ethers and their acetates it has not been described in detail whether the studies have been done on special isomers or on mixtures of isomers. In this evaluation it has, however, not been possible to distinguish between effects of special isomers and mixtures of isomers.

2-(2-Butoxyethoxy)-ethanol-(2-Butoxyethoxy)-ethanol (DGBE) CAS. no. 112-34-5

Acute toxicity	DGBE has low acute toxicity by the oral, dermal and inhalation routes. LD_{50} oral, mice, rat, guinea pigs and rabbit is 5.5 , 5-6, 2 and 2.2 g/kg respectively. No rats died by exposure to 120 mg/m; (the highest attainable vapour concentration). The substance is moderate-severe irritant to the eyes in rabbits and slight skin irritating. NOEL (five weeks) was by inhalation 120 mg/m; in rats.
Chronic toxicity	DGBE has been extensively tested by the dermal and oral routes in animals and caused no effects to target organs, fertility, developmental or nervous system. There are no reports of adverse effects in humans from use of DGBE-containing products. DGBE has been tested in many in vitro and in vivo systems. There was no evidence of genotoxicity in several test systems.
Human health effect	A case of hypersensitivity in an office worker has been reported. Patch test elicited a positive reaction to DGBE. Furthermore, one case of sensitization to DGBE with erythema and urticaria has been reported.
Odour	The odour threshold value has been measured to 0.009 mg/m; (VOCBASE, 1996) and 0.022 mg/m^3 (Boholt, 1992).

LCI LCI-value: 0.12 mg/m;
Justification: LCI is based on an inhalation study on animals, with a NOEL 120 mg/m; for irritation. LCI = NOEL/ SF ^{I} x SF ^{II} x SF ^{III} = 120 mg/m;/10 x 10 x 10 = 0.12 mg/m;.
The odour threshold value 0.02 mg/m; correspond to the C-value.

Butoxy propanolButoxy propanol (PGBE) CAS. no. 5131-66-8, 15821-83-7, 29387-86-8

(mixture).

Acute toxicity PGBE is low in single dose oral toxicity. LD_{50} oral, rats 1.9-5.2 g/kg. It is markedly irritating and somewhat injurious to the eyes, but only mildly irritating to the skin. 31 days inhalation study showed no effects in rats at 541 mg/m;. No sensitization in guinea pigs has been found.

Chronic toxicity NOEL by oral administration (13 weeks) to rats was 350 mg/kg/day. In reproduction studies (oral, dermal or injection studies) on mice, rats and rabbits there has been found no effects on maternal toxicity or on fetuses.

In Ames test PGBE was not mutagenic. It did not produce chromosomal aberrations in hamster ovary cells. No carcinogenic data available.

Odour The adjusted odour threshold value has been measured to 0.381 mg/m; (Boholt, 1992).

LCI LCI-value: 0.55 mg/m; (based on 0.541 mg/m;)
Justification: LCI is based on an inhalation study on animals, with a NOEL for eye lesions and irritation on 541 mg/m;.
LCI = NOEL/SF^{I} x SF ^{II} x SF ^{III} = 541 mg/m;/10 x 10 x 10 = 0.541 mg/m;.
The odour threshold value (0.4 mg/m;) corresponds to the C-value.

Butoxy propyl acetateButoxy propyl acetate CAS. no. 85409-76-3.

Toxicity No data available

LCI LCI-value: 0.55 mg/m;
Justification: No data available. The LCI is based on the fact that the glycol ether acetates have the same systemic toxicological effects as their parent glycol. The LCI for propylene glycol monobutyl ether is 0.541 mg/m; and this value is used as LCI for the acetate as well.

2-Ethoxy-ethyl acetate-Ethoxy-ethyl acetate (EGEEA) CAS. no. 111-15-9

Acute toxicity LD_{50} oral, mice, rats and guinea pigs respectively is 1.4 g/kg,
5.1 g/kg and 1.9 g/kg. It is moderate irritating to the eyes of rabbits,

slight irritating to the skin, poorly absorbed through the skin.
LC_{50} inhalation, rats 12100 mg/m; (8 h). No animals died after exposure for 1 hr to an atmosphere saturated with vapour. No gross pathological lesions were observed.

Chronic toxicity EGEEA causes effects on the haemapoitic system, on CNS and in liver and kidneys. EGEEA is a developmental toxicant and a teratogen in rats and rabbits when exposed by oral, dermal, or inhalation routes of exposure. EGEEA causes testicular effects in mice. The NOEL for teratogenic effects has been reported to be 270 mg/m; in rats and rabbits. No data are available on carcinogenic effects. No genotoxic effects were found in a number of in vivo and in vitro studies.

NIOSH has recommended a guideline (occupational) on 2.7 mg/m;.

Human health effects RD_{50} x 0.03/40 has been calculated to 3.0 mg/m; (VOCBASE, 1996).

Odour The odour threshold value is reported to be 0.1 mg/m; (VOCBASE, 1996). The odour threshold value (adjusted) has been measured to 0.447 mg/m; (Boholt, 1992).

LCI LCI-value: 0.27 mg/m;.
Justification: LCI is based on an inhalation study on animals (teratogenicity study), with a NOEL on 270 mg/m;.
LCI = NOEL/SF^{I} x SF^{II} x SF^{III} = 270 mg/m;/10 x 10 x 10 = 0.27 mg/m;.

2-Ethoxy hexyl acetate-Ethoxy hexyl acetate CAS. no. ?

Toxicity No data available

LCI LCI-value: 0.27 mg/m;. Justification: No data available. The LCI is based on the fact that the glycol ether acetates have the same systemic toxicological effects as their parent glycol. The LCI for ethylene glycol mono*ethyl* (not hexyl) ether is 0.27 mg/m; and is used as LCI for this acetate as well.

Methoxy propyl acetateMethoxy propyl acetate (PGMEA) CAS. no. 108-65-6, 70657-70-4, 84540-57-8 (mixture).

Acute toxicity LD_{50} oral, rats 4-14 g/kg.
LC_{50} inhalation, rats >23500 mg/m; (6h). It is not skin irritating in rabbits and only slightly eye irritating. No sensitization has been observed in guinea pigs. Exposure to 1620, 5400 or 16200 mg/m; in rats and mice for 9 days caused increased liver weight. All exposure levels caused histological irritation of the nasal mucosa for mice and the highest concentration in rats.

Chronic toxicity In an inhalation study (reproduction) in rats, 21600 mg/m; 2PG1MEA caused maternal toxicity. At 2700 mg/m; no toxicological effects were observed. No teratogenic or other developmental effects were seen in foetuses in any of the dose levels.

In another reproduction study on rats, 1PG2MEA caused maternal effects (irritation, sedation, weight decrease) at 2970 and 14580 mg/m;, but not at 594 mg/m;. At the highest concentration there also was an increased rate of fetal resorptions and decrease in fetal weights.

Studies of the metabolite 2PG1ME do not indicate effects on reproduction. There are no indications of mutagenicity or genotoxicity.

Odour The adjusted odour threshold value has been measured to 0.014 mg/m; for 2PG1MEA (Boholt 1992).

LCI LCI-value: 0.6 mg/m; (based on 0.594 mg/m;)
Justification: The LCI is based on an inhalation study on animals, with a NOEL for irritation, sedation and weight decrease for 1PG2MEA on 594 mg/m;.
LCI = NOEL/SF^{I} x SF^{II} x SF^{III} = 594 mg/m;/10 x 10 x 10 = 0.594 mg/m;.

Propylene glycol acetate and propylene glycol diacetatePropylene glycol acetate and propylene glycol diacetate. CAS. no. 627-69-0, 6214-01-3, 1331-12-0.

Acute toxicity LD_{50} oral, rats and guinea pigs 13530 and 3420 mg/kg respectively. Propylene glycol acetate is of a low degree of toxicity. No injuries have been reported from the compound.

Chronic toxicity No data available

LCI LCI-value: 0.55 mg/m;
Justification: No adequate data for an assessment. *Propylene glycol* (not the acetate) has in a number of studies been found relatively untoxic, acute and chronic, without irritative, genotoxic, reproductive or carcinogenic effects.
The LCI is here based on the LCI for the propylene glycol ethers.

2,2,4-Trimethyl-1,3-pentanediol-monoisobutyrate,2,4-Trimethyl-1,3-pentanediol-monoisobutyrate (Texanol^{R})
CAS. no. 25265-77-4

Toxicity The tentative exposure limit estimate of 1 mg/m; was published (Nielsen GD, 1997).

Odour Odour threshold value is not reported.
LCI LCI-value: 1 mg/m;
Justification: The LCI-value corresponds to the tentative exposure limit estimate.

HYDROCARBONSHYDROCARBONS

Aliphatic hydrocarbonsAliphatic hydrocarbons

AlkanesAlkanes C_2-C_4: ethane, propane, n-butane, iso-butane
C_5-C_6: n-pentane, iso-pentane, neo-pentan, hexane, n-hexane
C_7-C_{12}: heptane, octane, decane, undecane, dodecane

The toxicological evaluation is here based on C_7-C_{12} -alkanes.

Toxicity For many of the aliphatic hydrocarbons dermatitis, irritation, CNS depression and anaesthesia have been noted. The effect of the aliphatic hydrocarbons increases with the molecular weight. Methane and ethane are not irritating, but hexane causes eye irritation at 1800 mg/m;. Methane and ethane and propane are practically nontoxic as well as decane and undecane.

In general, aliphatic mixtures have an neurotoxic effect on the level about 100 ppm (200-600 mg/m;). Low molecular alkanes (C_2-C_4) are relatively non-toxic, have a low vapour pressure and a boiling point below 0°C.

Human health effects RD_{50}x 0.03/40 for heptane has been calculated to 54.5 mg/m; (VOCBASE, 1996).

Odour The odour threshold value has been reported to: Heptane(C_7) 40.7 mg/m;, Octane (C_8) 27.5 mg/m;, Nonane (C_9) 6.8 mg/m;, Decane (C_{10}) 4.4 mg/m;, Undecane (C_{11}) 3.5 mg/m; and Dodecane (C_{12}) 37.0 mg/m;.

LCI LCI-value: 20 mg/m;
Justification: LCI for C_7-C_{12}-alkanes is based on the general neurotoxic effect at 200-600 mg/m; in humans.
LCI = NOEL/ SF^{I} x SF^{II} x SF^{III} = 200-600 mg/m;/1 x 10 = 20-60 mg/m;.

By using RD_{50} (heptane) the LCI is 5.45 mg/m;.

Aromatic hydrocarbonsAromatic hydrocarbons

In general:
The aromatics are primary skin irritants, and repeated or prolonged skin contact may cause dermatitis. Eye contact may cause lacrimation and irritation. The acute toxicity is higher for toluene than for benzene, and decreases further with increasing chain length, except for the highly branched derivatives (C_8 to C_{18}). The alkylbenzenes are CNS depressants and neurotoxics.

C_2-AlkylbenzenesC_2-Alkylbenzenes (i.e. Ethylbenzene, Xylene).

EthylbenzeneEthylbenzene. CAS. no. 100-41-4

Acute toxicity — LD_{50} oral, rats 3.5 to 5.5 g/kg. It is a severe irritant to the eyes in rabbits and a mild skin irritant. Exposure to 668 mg/m; is irritating the eyes. Dermal contact causes erythema and inflammation.

Chronic toxicity — 13.6-136 mg/kg (oral) 182 days caused no effects in rats. There was no effects (inhalation) in rabbits and guinea pigs at concentrations of 1736 to 2604 mg/m;. It has not been fetotoxic in rats, mice or rabbits. Reproductive studies have been inconclusive.

Human health effects — Inhalation of 434 mg/m; in humans caused irritation.
The lowest published toxic concentration in humans has been reported to 434 mg/m; (8H) with irritation in nose and eyes.

RD_{50} x 0.03/40 has been calculated to 8 mg/m; (VOCBASE, 1996).

Odour — The odour threshold value is reported to 2-2.6 mg/m; (van Gemert, 1977) and to 10.2 mg/m; (VOCBASE, 1996).

LCI — LCI-value: 4.3 mg/m;
Justification: LCI is based on the irritation on humans with a LOEL on 434 mg/m;.
LCI = LOEL/ SF^{I} x SF^{II} x SF^{III} = 434 mg/m;/ 1 x 10 x 10 = 4.3 mg/m;.

The LCI does not correspond to the C-value 0.5 mg/m;. The criteria for standard setting (C-value) has not been available.

XylenesXylenes (isomers). CAS. no. 108-38-3

Acute toxicity — LC_{50} inhalation, rats 17000-23000 mg/m; (6H).

Chronic toxicity — Prolonged exposure to organic solvents cause organic brain damage. In general concentrations about 100 ppm have been found to be a NOEL for organic brain damage. High concentrations caused abortion and damage to fetuses in animals. 10 mg/m; have been found to be NOEL for teratagenic effects in animals. Xylenes have not been genotoxic.

Human health effects — Exposure to 400 mg/m; causes irritation in the eyes, nose and throat.

At higher concentrations nausea, vertigo and headache have been reported. Exposure to 870 mg/m; caused prolonged reaction time in humans.

Odour The odour threshold value is reported to be 1.4 mg/m; (VOCBASE, 1996) and the 'best estimated threshold value' is 0.078 mg/m; (Woodfield, 1994).

LCI LCI-value: 0.1 mg/m;
Justification: LCI is based on the animal study on a NOEL of 10 mg/m;.
LCI = LOEL/SF ^{I} x SF ^{II} x SF ^{III} = 10 mg/m;/10 x 10 x 1 = 0.1 mg/m;.

The LCI corresponds to the C-value.

C_3-Alkylbenzenes **C_3-Alkylbenzenes** C_3-Alkylbenzene i.e. trimethylbenzene, n-propylbenzene and isopropylbenzene (cymene). The LCI for the C_3-alkylbenzenes are estimated from the lowest LCI of the evaluated compounds.

Isopropylbenzene **Isopropylbenzene CAS. no. 98-82-8**

Acute toxicity LD_{50} oral, rats 1.4-2.9 g/kg.
LC_{50} inhalation, mice 11000 mg/m;.
Cymene appears slightly less toxic than its n-propyl isomer, but more so than benzene and toluene. It is an irritant to eyes and skin and a CNS depressant.

Chronic toxicity 154 mg/kg (oral), rats 194 days caused no effects.

2745 mg/m; for 150 days caused lung, liver and kidney effects.

Human health effects It is irritating in humans 1098 mg/m;. The irritation threshold has been reported to 175 mg/m; in humans.

RD_{50} x 0.03/40 has been calculated to 8.5 mg/m; (VOCBASE, 1996).

Odour The odour threshold value is reported to be 0.12 mg/m; (VOCBASE, 1996).

LCI LCI-value: 1.75 mg/m;
Justification: LCI is based on the irritation effect in humans, with a LOEL at 175 mg/m;.
LCI = LOEL/SF ^{I} x SF ^{II} x SF ^{III} = 175 mg/m;/1 x 10 x 10 = 1.75 mg/m;.

n-Propylbenzenen-Propylbenzene. CAS. no. 103-65-1

Acute toxicity	LD_{50}-value has been reported to 6g/kg and 4.4 g/kg in rats and mice respectively. The lowest concentration causing death (LC_{lo}) in mice was 20000 mg/m;.
Chronic toxicity	No genotoxicity has been found for n-propylbenzene in vitro or in vivo. No other data on chronical toxicity has been found.
Human health effects	RD_{50} x 0.03/40 has been calculated to 5.8 mg/m; (VOCBASE, 1996).
Odour	The odour threshold value is reported to be 0.048-0.100 mg/m; (VOCBASE, 1996, Woodfield).
LCI	LCI-value: 5.8 mg/m;. Justification: The RD_{50} calculation has been used for the LCI.

TrimethylbenzenesTrimethylbenzenes. CAS. no. 96-63-6, 108-67-8, 526-73-8,

In general:
The trimethylbenzenes occur in three isomeric forms hemimellitine, pseudocumene, mesitylene.

Acute toxicity	LD_{lo} oral 5000 mg/kg.
Chronic toxicity	Exposure to 1000 mg/m; caused inhibition of phagocytic actions.
Human health effects	Exposure to a mixture containing 30% mesitylene and 50% hemimellitine in concentrations of 50-300 mg/m; caused respiratory problems, headache, tiredness and thrombocytopenia.
Odour	The odour threshold value is reported to be 0.5 mg/m;.
LCI	LCI-value: 0.5 mg/m; Justification: LCI is based on the effects in humans, with a LOEL on 50 mg/m;. LCI = LOEL/SF^{I} x SF^{II} x SF^{III} = 50 mg/m;/1 x 10 x 10 = 0.5 mg/m;. The LCI-value does not correspond to the C-value 0.03 mg/m; estimated on the basis of odour.

C_4-Alkylbenzenes **C_4-Alkylbenzenes** i.e. Tetramethylbenzene (prenitine, isodurene, durene), cymene, diethylbenzene, butylbenzene.

Acute toxicity LD_{50} oral, rats >5 g/kg (durene), 2-5 g/kg (butylbenzene) and 5 g/kg (cymene). A single oral dose of 0.075 ml monobutylbenzene produced irreversible foreleg paralysis in rats.
LC_{lo} inhalation >20.000 mg/m;.

Chronic toxicity Rabbits exposed to tetraline in 30 days had lens opacities. Tetraline causes green coloured urine in humans. 1100 mg/m; C_9-C_{10}-aromates 90 days caused haematological changes, tremor, throat irritation and sedation in monkeys. In rats the same symptoms were observed, but at higher concentrations.
Exposure to 380 mg/m; (13 weeks) caused no symptoms.

Human health effects Workers handling tert-butyltolouene experience nasal irritation, nausea, malaise and headache. Exposure to 55 mg/m; cymene caused irritation in humans and 110 mg/m; caused acute CNS-symptoms.

RD_{50} x 0.03/40 (butylbenzene) has been calculated to 3 mg/m; (VOCBASE, 1996).

Odour The odour threshold value has been reported to:
durene 0.08 mg/m;, isodurene 0.01 mg/m;, tetraline 97 mg/m;.

LCI LCI-value: 0.55 mg/m;
Justification: LCI is based on the irritating effect in humans at 55 mg/m;.
LCI = LOEL/SF^{I} x SF^{II} x SF^{III} = 55 mg/m;/1 x 10 x 10 = 0.55 mg/m;.

The LCI-value for C_4-alkylbenzenes does not correspond to the C-value 0.02 mg/m; (based on 10% mixture of isodurene and an estimated odour threshold value of 0.002 mg/m;).

KETONESKETONES

In general:
Ketones are volatile organic compounds which can act on the central and peripheral nervous system, respiratory system, and kidney and liver function.

Ketones produce, when inhaled at lower concentrations, nausea and vomiting. They possess narcotic properties when inhaled in high concentrations.

Some ketones are neurotoxic, e.g. methylethylketone. Rat experiments showed nerve changes which were characteristic for peripheral neuropathy.

Recent reports indicate that prolonged exposure of workers to ketones may be associated with the possible development of peripheral neuropathy.

Ketones are irritating to the eyes and respiratory system. These properties are more distinct among the unsaturated ketones and in the higher members of the group.

AcetoneAcetone CAS. no. 67-64-1

Acute toxicity	LD_{50} oral, rat: 9750 mg/kg LD_{50} oral, rabbit: 5300 mg/kg LC_{lo} inhalation, rat: 38,000 mg/m m;/4 hours Mild skin irritation and moderate eye irritation were shown in experimental animals.
Chronic toxicity	No mutagenic, genotoxic or carcinogenic effects were reported.
Human health effects	Inhalation: High concentrations of acetone cause severe effects on the central nervous system, e.g. dizziness, nausea, loss of coordination. Inhalation of vapours at concentrations above 28500 mg/m; leads to acute intoxication shown as headache, vomiting, weakness, loss of consciousness. Acetone has no known effects on the peripheral nervous system. The critical effect of exposure to acetone is most probably irritation of the mucous membranes and eyes. Irritation of nose and throat was reported at 700 mg/m;, but not at 475 mg/m;. Skin contact: Skin contact with acetone for 30-90 minutes results in irritation and reversible changes within epidermis. Eye contact: Irritation. RD_{50} x 0.03/40 has been calculated to 77.5 mg/m; (VOCBASE, 1996).

Odour	Odour threshold value is reported to be 14 mg/m; (VOCBASE, 1996).
LCI	LCI-value: 0.4 mg/m; Justification: The LCI-value refers to irritation, systemic toxicity and consider the low odour threshold value. The LCI-value corresponds to the C-value.

Ô-ButyrolactoneÔ-Butyrolactone CAS. no. 96-48-0

Human health effects	After oral administration of large doses mild sedation was reported. IARC evaluation: possibly carcinogenic to humans, group 2B. No case reports or epidemiological studies were available for the evaluation of the carcinogenicity in humans.
Odour	Odour threshold value is not reported (VOCBASE, 1996).
LCI	The LCI-value can not be estimated and consequently Ô-butyrolactone is considered as an Aunknown@ compound.

CyclohexanoneCyclohexanone CAS. no. 108-94-1

Acute toxicity	LD_{50} oral, rat: 1620 mg/kg LD_{50} inhalation, rat: 32,000 mg/m;
Chronic toxicity	Inhalation study was carried out in rats exposed for 6 months, 4 hours per day for concentration of vapours of 64 mg/m;. Decreased reflex strength and decreased liver functions were seen as main results.
Human health effects	Inhalation: Cyclohexanone acts on the central nervous system increasing stimulatability and decreasing respiration rate. Volunteers were exposed for 3-5 minutes to a range of concentrations of cyclohexane in air. At the lowest concentration, of approximately 40 mg/m;, irritation of the eyes was reported. At a concentration of 80 mg/m; a marked irritation of the eyes, nose and throat was noted, whereas concentrations of 200 mg/m; resulted in irritation of the mucous membranes. Workers exposed in industrial environment for 5 years had changes in liver function and spermatozoa changes (deficient amount, absence, immobile or lifeless spermatozoa).
Odour	RD_{50} x 0.03/40 has been calculated to 2.3 mg/m; (VOCBASE, 1996). Odour threshold value is reported to be 0.083 mg/m; (VOCBASE,

1996).

LCI LCI-value: 2.3 mg/m;
Justification: The LCI-value refers to sensory irritation.

2,9-Decane dione,9-Decane dione CAS. no. ?

Toxicity No data available.

Odour Odour threshold value is not reported (VOCBASE, 1996).

LCI The LCI-value can not be estimated and consequently 2,9-decane dione is considered as an Aunknown@ compound.

Ethyl vinyl ketoneEthyl vinyl ketone CAS. no. 1629-58-9

Toxicity No toxicological information was available.

Odour Odour threshold value is reported to be 0.0017 mg/m; (VOCBASE, 1996).

LCI LCI-value: 0.002 mg/m;
Justification: The LCI-value corresponds to the odour threshold value, which is assumed to be below the concentration causing irritation.

2-Heptanone-Heptanone CAS. no. 110-43-0

Acute toxicity LD_{50} oral, rat: 1670 mg/kg
LC_{lo} inhalation, rat: 18,685 mg/m;

Chronic toxicity No information was available.

Human health effects Inhalation of vapours induces headache and may lead to dizziness and unconsciousness. Reports on abuse of 2-heptanone indicate severe peripheral nervous system damage that may lead to irreversible paralysis and death.

Skin contact: Prolonged or repeated skin contact results in drying and cracking of skin although 2-heptanone was not irritating or sensitizing.

Eye contact: Irritation and in some cases impaired vision were reported.

RD_{50} x 0.03/40 has been calculated to 2.3 mg/m; (VOCBASE, 1996)

Odour Odour threshold value is reported to be 0.68 mg/m; (VOCBASE,

1996).

LCI LCI-value: 2.3 mg/m;
Justification: The LCI-value refers to sensory irritation

3-Heptanone-Heptanone CAS. no. 106-35-4

Acute toxicity LD_{50} oral, rat: 270 mg/kg
LC_{lo} inhalation, rat: 9340 mg/m;
Mild irritant when applied on rabbit skin, whereas in rabbit eyes moderate irritant.

Chronic toxicity No information was available.

Human health effects Inhalation: Exposure to vapours of a concentration above 230 mg/m; results in irritation of skin whereas at higher concentrations narcosis was reported. No neurotoxicity or other chronic effects were reported.

Odour Odour threshold is not reported (VOCBASE, 1996).

LCI LCI-value: 2.3 mg/m^3
Justification: The LCI-value is based on an assumption that the effects of 3-heptanone is comparable to those of 2-heptanone.

2-Nonanone-Nonanone CAS. no. 821-55-6

Toxicity No information was available.

Odour Odour threshold value is reported to be 0.23 mg/m^3 (VOCBASE, 1996).

LCI LCI-value: 1.9 mg/m^3
Justification: The LCI-value is based on the assumption that the effects of 2-nonanone is comparable to those of 2-octanone.

2-Octanone-Octanone CAS. no. 111-13-7

Human health effects Irritant to skin and mucous membranes.

RD_{50} x 0.03/40 has been calculated to 1.9 mg/m^3 (VOCBASE, 1996).

Odour Odour threshold value is reported to be 0.09 mg/m^3 (VOCBASE, 1996).

LCI LCI-value: 1.9 mg/m;
Justification: The LCI-value refers sensory irritation.

4-Octene-3-one-Octene-3-one CAS. no. ?

Toxicity 4-Octene-3-one is a 8 carbon ketone. Several of such ketones e.g. 3,6-octanedione, 5-methyl-3-heptanone and 3,4-dimethyl-2,5-hexandione have been shown neurotoxic causing polyneuropathy.

Odour The odour threhold value is reported for 8 carbon ketones. For e.g. methyl-ethyl-ketone (2-butanone) the odour threshold is reported to be 15 mg/m;, for methyl-isobutyl-ketone 2.9 mg/m; and for diiso-butylketone 0.6 mg/m; (VOCBASE, 1996).

The lowest odour threshold value of 0.6 mg/m; is considered relevant.

LCI LCI-value: 0.6 mg/m;
Justification: The LCI-value corresponds to the defined odour threshold value and is assumed to be below the health effects for the compound.

TERPENESTERPENES

Terpenes. CAS. no. 68956-56-9

Human health effect

Monoterpenes may irritate the skin and mucous membranes and prolonged exposure in allergic and non-allergic contact dermatitis.

Turpentine (diterpene) is the oleoresin from pine species. The irritant and sensitizing potential varies according to the content of terpenes as α-pinene, 3-carene, limonene and camphene. The main allergen seems to be oxidation products of the diterpenes, in particular of 3-carene.

Higher frequencies of symptoms involving mouth and throat as well as feeling of chest oppression were observed in workers occupationally exposed to monoterpenes. Impairment in the lung function was observed after a weekend. The mean exposure was calculated to 254 mg/m; (range 100-550 mg/m;). Exposure to the monoterpenes α-pinene, β-pinene, 3-carene and d-limonene (the mixture of the compound) caused discomfort in the nose, throat and airways at 225 mg/m;.

Short-term-exposure to turpentine caused an increase in airway resistance. Workers from saw-mills were exposed to water and not water stored wood in concentrations of terpenes <25 mg/m; (low exposure group) and 50-240 mg/m; (mean 125 mg/m;) (high exposure group). There was a higher frequency of chronic bronchitis in the higher exposure group. In the low exposure group there were no complaints of any symptoms neither of irritation.

Chronic toxicity

No data available

Odour

Specific for each of the monoterpenes.

Standards

The Danish occupational exposure limit for monoterpenes, single or all together is 140 mg/m; and in the USA 556 mg/m;.

LCI

LCI-value: 0.25 mg/m;
Justification: LCI is based on an inhalation study on humans, with a NOEL for lung symptoms on 25 mg/m;. LCI = NOEL/ SF^{I} x SF^{II} x SF^{III} = 25 mg/m;/1 x 10 x 10 = 0.25 mg/m;

CampheneCamphene. CAS. no. 79-92-5

Acute toxicity	LD_{50} intra peritoneal, mice >500 mg/kg. LD_{50} oral, rats >5 g/kg, LD_{50} dermal, rabbits >2.5 g/kg. It inhibits plant and fungal growth and is a natural protector against insects and mites.
Chronic toxicity	No data available
Odour	The odour threshold value is reported to be 28 mg/m; (VOCBASE, 1996)
LCI	LCI-value: 0.25 mg/m; Justification: No adequate data for an assessment. The LCI is based on the LCI for terpenes (general).

2-Carene-Carene. CAS. no. 4497-92-1

Acute toxicity	It has been shown that 2-carene is a sensitizer, because of the hydroperoxides common in both 2-carene and 3-carene.
Chronic toxicity	No data available
LCI	LCI-value: 0.25 mg/m; Justification: No adequate data for an assessment. The LCI is based on the general LCI for terpenes.

3-Carene-Carene. CAS. no. 13466-78-9

Acute toxicity	LD_{50} oral, rats 4800 mg/kg. Exposure to 5000 mg/m; 10-20 min of 3-carene induced a marked bronchi-constriction in isolated, perfused and ventilated lungs from pigs and rats.
Chronic toxicity	3-Carene has been found mutagenic in Ames test without but not with metabolic activation.
Human health effects	An oxidation product of 3-carene (probably a hydroperoxide) is thought to be the causal factor to the observed irritative and sensitizing effects. 3-Carene induces contact allergy in pigs and sensitize guinea pigs. In case studies 3-carene has been found to be the specific sensitizer in the terpenes. 450 mg/m; 3-carene caused discomfort in the eyes experimentally inhumans. No effects were found at 225 mg/m;.
Odour	No data available.

LCI

LCI-value: 0.25 mg/m;
Justification: LCI is based on an inhalation study in humans, with a NOEL on 225 mg/m;.
'LCI' = NOEL/SF^{I} x SF^{II} x SF^{III} = 225 mg/m;/1 x 10 x 10 = 2.25 mg/m;.

The LCI is based on the LCI-value for terpenes in general.

LimoneneLimonene. d,l-limonene CAS. no. 138-86-3, d-limonene CAS. no. 5989-27-5,

l-limonene CAS. no. 5989-54-8

Acute toxicity

LD_{50} oral, rats and mice 5.6-6.6 and 4.4-5.2 g/kg respectively.
d-Limonene (high concentrations) is a skin irritant. The oxidation product of limonene, the hydro peroxides is proved to be a potent contact allergen when tested on guinea pigs.

Chronic toxicity

Slightly lower mean body weights in rats at 150 mg/kg (2 y) and in mice at 1000 mg/kg were seen. Oral dose levels 400-500 mg/kg (1-3 months) induced changes in liver enzymes in rats. 75 mg/kg (3 months) caused increased liver weight but no other toxic effects.

Reproduction studies on rats, mice and rabbits have shown increased incidence of skeletal abnormalities and decreased organ weights in fetuses at doses showing maternal toxicity. The highest dose level without effects was 591 mg/kg.

d-Limonene causes kidney effects (including increased incidence of renal tumours) in male rats. Production of the protein α-2u-globulin is considered to be the origin to the observed lesions. This protein has not been observed to occur in any other species than male rats. Experimental studies on guinea pigs have shown, that d-limonene itself gives no significant contact allergy, but it caused contact allergy, while air oxidized.

Limonene did not show any mutagenicity when tested in several in vivo or in vitro systems.

Human health effects

A slight decrease in vital capacity (2%), probably of no functional significance, was noted in an experimental exposure study in concentrations of 450 mg/m; in humans. d-Limonene is considered as the principal sensitizer in citrus species. It is also included among the fragrance allergens. A number of case reports on dermal contact allergy to limonene have been found.

Odour

The odour threshold value is reported to be 2.5 mg/m; -(VOCBASE,

1996).

LCI LCI-value: 0.3 mg/m;
Justification: The LCI is based on an inhalation study on animals, with a LOEL on 75 mg/kg, and conversion from oral exposure to inhalation.
LCI = LOEL x 75 kg/SF^{I} x SF^{II} x SF^{III} x 20 m; =
75 mg/kg x 70 kg/10 x 10 x 10 x 20 m; = 0.3 mg/m;.

β-Myrceneβ-Myrcene. CAS. no. 123-35-3

Acute toxicity LD_{50} oral, rats >5 g/kg in rats. It is a moderate skin irritant in rabbits.

Chronic toxicity Myrcene resulted in an oral reproduction study in decreased birth weight and increased perinatal mortality and skeletal system disorders in fetuses. There were no adverse effects in maternal or fetuses at doses below 500 mg/kg.

Human health effects One case of type 1 allergy (asthma and rhino conjunctivitis) to β-myrcene has been reported (positive scratch test).

Odour The odour threshold value is reported to be 0.14 mg/m; (VOCBASE, 1996).

LCI LCI-value: 1.7 mg/m;
Justification: LCI is based on a reproduction study (oral) in animals, with a NOEL on 500 mg/kg and a conversion from oral to inhalation exposure.
LCI = NOEL x 70 kg/SF^{I} x SF^{II} x SF^{III} x 20 m; =
500 mg/m; x 70 / 10 x 10 x 10 x 20 = 1.7 mg/m;

α-Phellandreneα-Phellandrene. CAS. no. 99-83-2

Acute toxicity LD_{50} oral, rats 5.7 g/kg.

Chronic toxicity No data available

Human health effects Concentrated α-phellandrene causes severe skin irritation.

Odour The odour threshold value is reported to be 3.4 mg/m; (VOCBASE, 1996).

LCI LCI-value: 0.25 mg/m;
Justification: No adequate data for an assessment. The LCI is based on the LCI for terpenes (general).

α-Pineneα-Pinene. CAS. no. 80-56-8

Acute toxicity

LD_{50} oral, rats 2.3-5.1 g/kg.
LC_{50} inhalation, rats 11700 mg/m; (6 h). α-pinene is a skin and throat irritant. LC_{lo} inhalation, rats and guinea pigs 625 mg/m; and 572 mg/m; respectively.

Guinea pigs were sensitized by α-pinene in one study, but this could not be repeated by another research group. In general, allergic reactions to α-pinene are considered to be due to 3-carene present as an impurity.

Chronic toxicity

Pinene caused leukemic changes in fowl, and deviations in plasma proteins and erythroblastosis. It is not mutagenic in Ames test. By dermal exposure α-pinene was found to be a promoter (cancer), but the effect is probably caused by the skin irritation.

Human health effects

The human oral fatal dose is 180 g. Few patients have been reported specifically allergic to α-pinene. Subjects with cardiac diseases may experience increased olfactory sensitivity toward pinene.
450 mg/m m; of α-pinene caused irritation of the eyes, nose and/or throat during experimental exposure, while 225 mg/m; caused no symptoms.

Odour

The odour threshold value is reported to be 3.9 mg/m; (VOCBASE, 1996).

LCI

LCI-value: 0.25 mg/m;
Justification: LCI is based on an inhalation study in humans, with a NOEL on 225 mg/m;.
LCI = NOEL/ SF^{I} x SF^{II} x SF^{III} = 225 mg/m;/ 1 x 10 x 10 = 2.25 mg/m;.

The LCI is based on the LCI on terpenes (general).
This value differs from the C-value 0.05 mg/m; because of using a SF^{III} on 100 and a LOEL on 50 mg/m;.

β-Pineneβ-Pinene. CAS. no. 18172-67-3, 127-91-3

Toxicity

No data available

Odour

The odour threshold value is reported to be 36 mg/m; (VOCBASE, 1996)

LCI LCI-value: 0.25 mg/m;
Justification: No adequate data for an assessment. The LCI is based on the LCI for terpenes (general).

α-Terpineneα-Terpinene. CAS. no. 99-86-5

Acute toxicity LD_{50} oral, rats 1680 mg/kg. α-Terpinene may be a minor allergen although d-limonene is considered to be the principal sensitizer in Citrus species.

Chronic toxicity No data available

Odour Odour threshold value is reported to be 2.3 mg/m; (VOCBASE, 1996)

LCI LCI-value: 0.25 mg/m;
Justification: No adequate data for an assessment. The LCI is based on the LCI for terpenes (general).

γ-Terpineneγ-Terpinene (p-menthadiene-1,3). CAS. no. 99-85-4

Toxicity No data available

Odour Odour threshold value is reported to be 1.5 mg/m; (VOCBASE, 1996)

LCI LCI-value: 0.25 mg/m;
Justification: No adequate data for an assessment. The LCI is based on the LCI for terpenes (general).

Sesquiterpenes (unidentified). i.e. cadinene. CAS. no. 29350-73-0.

Acute toxicity No data available

Chronic toxicity Cadinene has been found to be a mutagen in Ames test. No other data available.

Human health effects Sesquiterpene-lactones as allantolactone, parthenin, costunolide etc are potent skin sensitizers. Air borne plant remains may cause symptoms. These sensitizing sesquiterpene-lactones are mainly found in plants from the compositae plant family, and probably not present among the unidentified sesquiterpenes in emissions from the tested wood-based materials.

LCI LCI-value: 0.25 mg/m;
Justification: No adequate data for an assessment. The LCI is based on the LCI for terpenes (general).

Terpene alchohols and ketonesTerpene alchohols and ketones

4-Terpineol-Terpineol CAS. no. 98-55-5 and α-Terpineolα-Terpineol CAS. no. 10482-56-1

Acute toxicity	LD_{50} oral, rats 5.17 mg/kg.
Chronic toxicity	No data available
Odour	Odour threshold value is reported to be 12 mg/m; (4-Terpineol) and 0.24 mg/m; (α-Terpineol) (VOCBASE, 1996).
LCI	LCI-value: 0.25 mg/m; Justification: No adequate data for an assessment. The LCI is based on the LCI for terpenes (general).

VerbenoneVerbenone. CAS. no. 18309-32-5

Acute toxicity	LD_{lo} intra peritoneal, rats 250 mg/kg.
Chronic toxicity	No data available
LCI	LCI-value: 0.25 mg/m; Justification: No adequate data for an assessment. The LCI is based on the LCI for terpenes (general).

Terpene epoxidesTerpene epoxides

Limonene oxideLimonene oxide. CAS. no. 1195-92-2.

Acute toxicity	Limonene-1,2-oxide has been found to be a potent contact allergen.
Chronic toxicity	No data available
LCI	LCI-value: 0.25 mg/m; Justification: No adequate data for an assessment. The LCI is based on the LCI for the terpenes (general).

OTHERSOTHERS

AcetalsAcetals

In general:
Acetals are polymers containing formaldehyde and alcohols or aldehydes. Skin irritation and sensitization tests in humans have shown mild to moderate erythema. In one person known sensitive to formaldehyde no reaction was found.

Formaldehyde butyl isobutylacetalFormaldehyde butyl isobutylacetal

Toxicity No data available

LCI The LCI-value can not be estimated and consequently the substance is considered as an Aunknown@ compound.

Formaldehyde dibutylacetalFormaldehyde dibutylacetal

Toxicity No data available

LCI The LCI-value can not be estimated and consequently the substance is considered as an Aunknown@ compound.

Formaldehyde diisobutylacetalFormaldehyde diisobutylacetal CAS. no. 2568-91-4

Toxicity No data available

LCI The LCI-value can not be estimated and consequently the substance is considered as an Aunknown@ compound.

EpoxidesEpoxides

Pentyl oxiranePentyl oxirane. CAS. no. ?

Toxicity The toxicity ranges from highly active low molecular-weight mono- and diepoxides to the inert cured resin systems possessing only few epoxy groups per molecule. Effects most commonly observed in animals have been dermatitis, eye irritation, throat and pulmonary irritation, gastric irritation. Although most compounds are mutagenic to bacteria, not all have produced tumours in animals. A few of the epoxides have been shown teratogenic in animals. Ethylene oxide has been placed as a CAR 2 carcinogen with a C-value on 0.005 mg/m; and propylene oxide as CAR 2, R45 with a C-value on 0.003 mg/m;.

LCI The LCI-value can not be estimated and consequently the substance is considered as an Aunknown@ compound.

The lowest C-value for other epoxides i.e. ethylene oxide and propylene oxide (methyl oxirane): propylene oxide 0.003 mg/m; might be used as a guiding value.

NitrilesNitriles

2,2'-Azobis-isobutyronitrile,2'-Azobis-isobutyronitrile. CAS. no. 78-67-1.

Toxicity LD_{50} oral, rats 700 mg/kg and LD_{lo} 30 mg/kg. Nitriles display toxicologic effects that appear to be related to cyanide toxicity. However, not all nitriles dissociate readily to produce cyanide. The toxicity of the individual nitriles is very different. It is therefore difficult to consider them collective. The C-value for acetonitrile is 0.1 mg/m; and for acrylonitrile 0.002 mg/m;.
The TLV's for the compounds are 70 and 4 mg/m; respectively.

LCI This compound is considered unknown because of lack of data.

The C-value for acrylonitrile 0.002 mg/m; might be used as a guiding value.

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Unless otherwise stated the toxicological assessments are based on information obtained from the databases: NIOSH-tis, RTCECS and ECDIN (the Environmental Chemical Data and Information Network, the Commission of the European Communities) and in the references below.

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Appendix 8
Evaluation
Survey of Results

Appendix 8
Evaluation - Survey of Results

The results comprise the comfort and health evaluations of emissions from the 23 investigated wood and wood-based materials.

The evaluations comprise determination of:

- S-value based on $\Sigma c_i/LC_i$ for stated effect type
- Indoor-relevant time-value based on odour and irritation thresholds

by material loads varying from 0,4 m^2/m^3 (corresponding to e.g. floor or table with 6 chairs) to 2.2 m^2/m^3 (corresponding to e.g. ceiling, floor and all 4 walls).

In the tables essential single substances are defined so that "other" substances in the emission do not exceed 10% of the S-value.

Reference is made to Appendix 6 regarding results and other data used as the basis of the calculation of S-values and indoor-relevant time-values, hereunder:

- Emission rate [$\mu g/m^2 h$] (from chamber testing).

- Calculated standard room concentration [$\mu g/m^3$].

- Lowest concentration of interest in the indoor air, LCI [$\mu g/m^3$].

- Odour- and irritation threshold values [$\mu g/m^3$] for determination of the indoor-relevant time-value.

1 Solid ash Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Formaldehyde	50-00-0	Irritation	0.08-0.48	0.06-0.36	nd	
		Propanal	123-38-6	Irritation	<0.01-0.01	<0.01	<0.01	14 and 26 based on odour
	Ketones	Acetone	67-64-1	Irritation	0.12-0.64	0.10-0.60	0.03-0.18	
	Several types	Others		Irritation	<0.01-<0.179	<0.02	<0.01	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				0.2-1.3	0.2-1.0	0.03-0.2	14 and 26

nd Below the detection limit of the method

Common material loads deviate from the calculated interval.

9 Primary α-pinene

2 Solid oak Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Formaldehyde	50-00-0	Irritation	0.08-0.40	0.08-0.40	nd	
		Butanal	123-72-8	Irritation	<0.01	<0.01-0.01	<0.01-0.01	<4 and 21 based on odour
	Ketones	Acetone	67-64-1	Irritation	0.14-0.78	0.18-1.02	0.08-0.40	
	Several types	Others		Irritation	<0.01-<0.02	<0.01-<0.08	<0.01	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				0.2-1.2	0.2-1.5	0.1-0.4	<4 and 21

nd Below the detection limit of the method
General material loads deviate from the calculated interval.

3 Solid beech Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Formaldehyde	50-00-0	Irritation	0.02-0.14	0.04-0.22	nd	
		Hexanal	66-25-1	Irritation	<0.01-0.04	<0.01-0.01	<0.01	<4 and >27 based on odour
		Propanal	123-38-6	Irritation	<0.01	<0.01	<0.01	14 and 26 based on odour
	Ketones	Acetone	67-64-1	Irritation	0.06-0.34	0.10-0.60	0.04-0.18	
	Several types	Others		Irritation	<0.01	<0.02	<0.01	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				0.1-0.6	0.2-0.8	0.04-0.2	14 and >27

nd Below the detection limit of the method
General material loads deviate from the calculated interval.

4 Solid spruce Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Acetaldehyde	75-07-0	Irritation	0.04-0.26	0.02-0.12	<0.01-0.04	8 and >27 based on odour
		Formaldehyde	50-00-0	Irritation	0.04-0.22	0.04-0.26	nd	
		Hexanal	66-25-1	Irritation	0.02-0.06	<0.01-0.03	<0.01-0.02	6 and >27 based on odour
		Propanal	123-38-6	Irritation	<0.01-0.01	<0.01-0.01	<0.01	12 and >27 based on odour
	Ketones	Acetone	67-64-1	Irritation	0.08-0.44	0.10-0.56	0.04-0.24	
	Terpenes	Limonene	138-86-3	Irritation	0.06-0.38	0.06-0.30	0.04-0.20	
		α-Pinene	80-56-8	Irritation	0.14-0.80	0.08-0.38	0.04-0.22	
	Several types	Others		Irritation	<0.02-<0.2	<0.01-<0.1	<0.1	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				0.4-2.4	0.3-1.8	0.1-0.7	12 and >27

nd Below the detection limit of the method

6 Particle board (MUPF-glue) Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and- 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Alcohols	Phenol	108-95-2	Irritation	0.28-1.54	0.60-2.30	nd	
	Aldehydes	Formaldehyde	50-00-0	Irritation	0.46-2.56	0.44-2.38	0.38-2.12	<3 and >28 based on irritation
		Hexanal	66-25-1	Irritation	<0.01-0.06	<0.01-0.04	<0.01-0.04	7 and >28 based on odour
		Octanal	124-13-0	Irritation	<0.01	<0.01	<0.01	10<t<28 and >28 based on odour
		Pentanal	110-62-3	Irritation	<0.01	<0.01	<0.01	<4 and >28 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.21-1.16	0.16-0.88	nd	
	Ketones	Acetone	67-64-1	Irritation	0.46-2.54	0.22-1.22	0.12-0.60	
	Several types	Others		Irritation	<0.01-<0.2	<0.01-<0.2	<0.01	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				1.4-8.0	1.4-8.2	0.5-2.8	10<t<28 and >28

nd Below the detection limit of the method
General material loads deviate from the calculated interval.

7 Particle board (UF-glue) Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Formaldehyde	50-00-0	Irritation	0.68-3.70	0.68-3.70	0.68-3.78	>28 based on irritation
		Hexanal	66-25-1	Irritation	<0.01-0.06	<0.01-0.05	<0.01-0.04	20 and >28 based on odour
		Pentanal	110-62-3	Irritation	<0.01	<0.01	<0.01	<4 and >28 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.18-1.02	0.13-0.73	0.08-0.44	
	Ketones	Acetone	67-64-1	Irritation	0.36-1.98	0.14-0.82	0.08-0.42	
	Several types	Others		Irritation	<0.01-<0.04	<0.05	<0.01	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				1.2-6.8	1.0-5.4	0.8-4.6	>28

General material loads deviate from the calculated interval.

8 Particle board (PU-glue) Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Formaldehyde	50-00-0	Irritation	0.10-0.58	nd	nd	
		Hexanal	66-25-1	Irritation	0.04-0.20	0.02-0.14	<0.01-0.06	>28 based on odour
		Nonanal	124-19-6	Irritation	<0.01-0.02	<0.01-0.01	nd	15 and >28 based on odour
		Pentanal	110-62-3	Irritation	<0.01-0.03	<0.01-0.02	<0.01-0.01	19 and >28 based on odour
		Propanal	123-38-6	Irritation	<0.01-0.01	<0.01-0.01	<0.01	15 and >28 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.24-1.32	0.24-1.32	nd	
	Ketones	Acetone	67-64-1	Irritation	1.10-6.06	0.62-3.40	0.20-1.10	
	Several types	Others		Irritation	<0.02-<0.1	<0.02-<0.1	<0.01-<0.03	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				1.5-8.3	0.9-5.0	0.2-1.2	>28

nd Below the detection limit of the method
General material loads deviate from the calculated interval.

9 Plywood (Phenolic-glue) Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Formaldehyde	50-00-0	Irritation	0.06-0.36	nd	nd	
		Hexanal	66-25-1	Irritation	0.02-0.08	0.02-0.06	0.02-0.06	>27 based on odour
		Pentanal	110-62-3	Irritation	0.02-0.06	<0.01-0.02	<0.01-0.01	10 and >27 based on odour
		Propanal	123-38-6	Irritation	<0.01	<0.01	<0.01	<4 and >27 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.13-0.73	0.08-0.44	nd	
	Ketones	Acetone	67-64-1	Irritation	0.12-0.62	0.10-0.50	0.12-0.70	
	Several types	Others		Irritation	<0.01-<0.05	<0.01	<0.01-0.03	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				0.3-1.9	0.2-1.0	0.1-0.8	>27

nd Below the detection limit of the method
General material loads deviate from the calculated interval.

10 MDF (UF-glue) Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Formaldehyde	50-00-0	Irritation	0.84-4.58	0.86-4.76	0.74-4.10	>28 based on irritation
		Hexanal	66-25-1	Irritation	<0.01-0.02	<0.01-0.01	<0.01-0.01	<4 and >28 based on odour
		Propanal	123-38-6	Irritation	<0.01	<0.01	<0.01	<4 and >28 based on odour
	Ketones	Acetone	67-64-1	Irritation	0.06-0.30	0.04-0.26	0.08-0.48	
	Several types	Others		Irritation	<0.01-<0.2	<0.01	<0.01	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				0.9-5.1	0.9-5.0	0.8-2.6	>28

General material loads deviate from the calculated interval.

11 Beech veneered particle board - veneering with PVA-glue Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Alcohols	Benzyl alcohol	100-51-6	Irritation	2.08-11.44	1,76-9.68	1.60-8.80	
	Aldehydes	Formaldehyde	50-00-0	Irritation	0.12-0.62	0.04-0.26	0.06-0.30	
		Hexanal	66-25-1	Irritation	<0.01-0.02	<0.01-0.01	<0.01-0.01	<4 and >27 based on odour
		Pentanal	110-62-3	Irritation	<0.01-0.02	<0.01-0.02	<0.01-0.01	11 and >27 based on odour
	Ketones	Acetone	67-64-1	Irritation	0.06-0.34	0.06-0.28	0.06-0.30	
	Several types	Others		Irritation	<0.2	0.01-<0.2	<0.01-<0.1	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				2.4-12.6	1.8-10.4	1.7-9.5	11 and >27

General material loads deviate from the calculated interval.

12 Beech veneered particle board - veneering with UF-glue Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Formaldehyde	50-00-0	Irritation	2.02-11.08	1.28-7.08	0.84-4.58	>28 based on irritation
		Hexanal	66-25-1	Irritation	<0.01-0.02	<0.01-0.02	<0.01-0.02	<4 and >28 based on odour
		Propanal	123-38-6	Irritation	<0.01-0.01	<0.01-0.01	<0.01	13 and >28 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.13-0.73	0.10-0.58	0.08-0.44	
	Ketones	Acetone	67-64-1	Irritation	0.14-0.80	0.12-0.66	0.10-0.54	
	Several types	Others		Irritation	<0.1	<0.01-<0.05	<0.01-<0.02	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				2.4-12.7	1.5-8.4	1.0-5.6	>28

General material loads deviate from the calculated interval.

13 Solid pine - heartwood from northern Finland Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling. floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Hexanal	66-25-1	Irritation	0.02-0.12	0.02-0.04	<0.01-0.04	22 and >28 based on odour
		Pentanal	110-62-3	Irritation	<0.01-0.02	<0.01	<0.01	4 and >28 based on odour
		Propanal	123-38-6	Irritation	<0.01	<0.01	<0.01	<3 and >28 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.13-0.73	0.13-0.73	0.26-1.46	
	Ketones	Acetone	67-64-1	Irritation	0.16-0.86	0.10-0.56	0.04-0.22	
	Terpenes	Limonene	138-86-3	Irritation	0.50-2.78	0.40-2.20	0.34-1.90	
		α-Pinene	80-56-8	Irritation	31.36-172.48	26.88-147.84	15.04-82.72	>28 based on odour
	Several types	Others		Irritation	<0.2-<2.9 #	<0.1-<0.4 #	<0.4-<2.1 9	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				$32.3-$179.9	$27.6-$151.8	16.1-88.4	>28

Excessive exposure of adsorption tubes by sampling may result in under estimation of c/LCI for terpenes

9 Primary camphene and β-pinene.

14 Solid pine - sapwood from northern Finland Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Hexanal	66-25-1	Irritation	0.02-0.10	0.02-0.08	0.02-0.06	>28 based on odour
		Pentanal	110-62-3	Irritation	<0.01-0.01	<0.01	<0.01	<3 and >28 based on odour
		Propanal	123-38-6	Irritation	<0.01-0.01	<0.01	<0.01	8 and >28 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.13-0.73	0.26-1.46	0.26-1.46	
	Ketones	Acetone	67-64-1	Irritation	0.20-1.06	0.12-0.70	0.06-0.34	
	Terpenes	3-Carene	13466-78-9	Irritation	1.08-5.98 #	1.28-7.04 #	1.44-7.92	>28 based on odour
		α-Pinene	80-56-8	Irritation	3.52-19.36	1.24-6.86 #	1.60-8.80	
	Several types	Others		Irritation	<0.2-<0.9 #	<0.01-<0.1#	<0.2-<0.9 9	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				$5.1-$28.1	$2.9-$16.2	3.6-19.5	>28

Excessive exposure of adsorption tubes by sampling may result in under estimation of c/LCI for terpenes

9 Primary limonene.

15 Solid pine - heartwood from south Sweden Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Hexanal	66-25-1	Irritation	0.10-0.56	0.04-0.20	0.02-0.12	>28 based on odour
		Pentanal	110-62-3	Irritation	0.02-0.09	<0.01-0.04	<0.01-0.02	>28 based on odour
		Propanal	123-38-6	Irritation	<0.01	<0.01	<0.01	<3 and >28 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.26-1.46	0.26-1.46	0.26-1.46	
	Ketones	Acetone	67-64-1	Irritation	0.28-1.56	0.12-0.66	0.06-0.36	
	Hydrocarbons aromatic	C4-Alkyl-benzenes		Irritation	0.04-0.20	0.02-0.16	0.02-0.14	<3 and >28 based on odour
	Terpenes	3-Carene	13466-78-9	Irritation	5.12-28.16 #	3.84-21.12 #	8.00-44.00	>28 based on odour
		Limonene	138-86-3	Irritation	0.16-0.86	0.14-0.74	0.14-0.74	
		α-Pinene	80-56-8	Irritation	12.16-66.88	8.32-45.76	8.64-47.52	>28 based on odour
	Several types	Others		Irritation	<0.3-<1.9 #	<0.3-<1.3 #	<0.4-<1.9 9	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				18.4-101.6	13.0-71.4	17.5-96.2	>28

Excessive exposure of adsorption tubes by sampling may result in under estimation of c/LCI for terpenes

9 Primary camphene, β-pinene and 2-carene

16 Solid pine - sapwood from south Sweden Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Butanal	123-72-8	Irritation	<0.01-0.02	<0.01-0.02	<0.01	<3 and >28 based on odour
		Hexanal	66-25-1	Irritation	0.24-1.30	0.12-0.66	0.04-0.26	>28 based on odour
		Pentanal	110-62-3	Irritation	0.04-0.18	0.02-0.10	<0.01-0.04	>28 based on odour
		Propanal	123-38-6	Irritation	0.02-0.10	0.02-0.06	<0.01-0.02	>28 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.16-0.58	0.53-2.93	0.53-2.93	
	Ketones	Acetone	67-64-1	Irritation	0.54-2.92	0.22-1.16	0.06-0.30	
	Hydrocarbons, aromatic	C4-Alkyl-benzenes		Irritation	0.04-0.16	nd	0.02-0.14	<3 and >28 based on odour
	Terpenes	3-Carene	13466-78-9	Irritation	2.72-14.96 #	2.02-11.08#	2.88-15.84	<28 and >28 based on odour
		α-Pinene	80-56-8	Irritation	9.92-54.56 #	14.72-80.96#	6.08-33.44	9<t<28 and >28 based on odour
	Several types	Others		Irritation	<0.3-<1.9 #	<0.3-<1.4 #	<0.2-<0.79	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				$13.9-$76.6	$17.9-$98.3	9.8-54.0	>28

nd Below the detection limit of the method

Excessive exposure of adsorption tubes by sampling may result in under estimation of c/LCI for terpenes

9 Primary camphene, limonene and β-pinene.

17 OSB (Phenolic-glue) Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Butanal	123-72-8	Irritation	<0.01-0.01	<0.01-0.01	<0.01	<3 and >28 based on odour
		Decanal	112-31-2	Irritation	<0.01-0.02	<0.01	<0.01	>28 based on odour
		Formaldehyde	50-00-0	Irritation	0.20-1.10	0.16-0.88	0.16-0.88	<3 and >28 based on irritation
		Heptanal	11-71-7	Irritation	<0.01-0.04	<0.01-0.01	<0.01-0.01	14 and >28 based on odour
		Hexanal	66-25-1	Irritation	0.04-0.20	0.02-0.12	0.02-0.10	>28 based on odour
		Nonanal	124-19-6	Irritation	0.02-0.06	<0.01-0.04	<0.01-0.03	>28 based on odour
		Octanal	124-13-0	Irritation	0.02-0.08	0.02-0.06	<0.01-0.04	>28 based on odour
		Pentanal	110-6-2-3	Irritation	0.02-0.07	<0.01-0.04	<0.01-0.03	>28 based on odour
		Propanal	123-38-6	Irritation	<0.01-0.01	<0.01-0.01	<0.01	17 and >28 based on odour
		Acrolein	107-02-8	Irritation Allergy	0.53-2.93	0.53-2.93	0.13-0.73	
		Furfural	98-01-1	Irritation	2.40-13.20	1.60-8.80	nd	
	Alcohols	1-Pentanol	71-41-0	Irritation	0.02-0.10	<0.01-0.04	<0.01-0.01	28 and >28 based on odour
	Ketones	Acetone	67-64-1	Irritation	0.44-2.42	0.28-1.54	0.22-1.18	
	Acids	Pentanoric acid	109-52-4	Irritation	0.44-2.42	0.16-0.90	0.10-0.56	>28 based on odour
	Several types	Others		Irritation	<0.3-<1.5	<0.2-<0.6	<0.02-<0.2	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				4.4-24.1	2.9-15.9	0.7-3.7	>28

nd Below the detection limit of the method

#	General material loads deviate from the calculated interval

18 Urethan alkyd and linseed oil on solid beech Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Hexanal	66-25-1	Irritation	0.06-0.30	0.02-0.14	0.02-0.06	>28 based on odour
		Pentanal	110-62-3	Irritation	<0.01-0.04	<0.01-0.02	<0.01	11 and >28 based on odour
		Propanal	123-38-6	Irritation	0.02-0.16	0.02-0.08	<0.01-0.04	>28 based on odour
		Acrolein	107-02-8	Irritation Allergy	<0.02-0.14	0.08-0.44	0.05-0.29	
		2-Pentenal	1576-87-0	Irritation	5.20-28.60	1.20-6.60	nd	
	Ketones	Acetone	67-64-1	Irritation	0.08-0.46	0.06-0.38	0.06-0.30	
		Vinyl ethyl ketone	1129-58-9	"Odour"	1.60-8.80	nd	nd	
	Hydrocarbons	Alkanes		Irritation	0.22-1.26	0.14-0.74	0.08-0.44	18 and >28 based on odour
		C2-Alkyl-benzenes		Irritation	0.62-3.38	0.24-1.28	0.04-0.18	
		C4-Alkyl-benzenes		Irritation	0.10-0.52	0.04-0.24	0.02-0.06	9 and >28 based on odour
	Several types	Others		Irritation	<0.1-<0.6	<0.01-<0.2	<0.03	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				8.0-44.2	1.8-10.1	0.3-1.4	>28

nd Below the detection limit of the method
General material loads deviate from the calculated interval.

19 Resin- and linseed oil on solid beech Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load # 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load # 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Heptanal	111-71-7	Irritation	<0.01-0.02	<0.01-0.01	<0.01	5 and >28 based on odour
		Hexanal	66-25-1	Irritation	0.02-0.10	0.02-0.06	<0.01-0.02	19 and >28 based on odour
		Octanal	124-13-0	Irritation	<0.01-0.04	<0.01-0.04	<0.01	>28 based on odour
		Pentanal	110-62-3	Irritation	<0.01-0.01	<0.01	<0.01	<4 and >28 based on odour
		Propanal	123-38-6	Irritation	0.02-0.10	<0.01-0.05	<0.01-0.01	>28 based on odour
		Acrolein	107-02-8	Irritation Allergy	<0.02-0.14	0.08-0.44	0.05-0.29	
	Ketones	Acetone	67-64-1	Irritation	0.16-0.88	0.12-0.68	0.08-0.44	
	Hydrocarbons	Alkanes		Irritation	0.08-0.46	0.08-0.38	0.06-0.30	<4 and >28 based on odour
		C2-Alkyl-benzenes		Irritation	0.18-1.02	0.02-0.14	0.02-0.08	
	Terpenes	Limonene	138-86-3	Irritation	0.12-0.64	0.04-0.26	0.02-0.08	
	Several types	Others		Irritation	<0.06-<0.3	<0.03-<0.1	<0.01-<0.1	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				0.7-3.7	0.4-2.2	0.2-1.3	>28

General material loads deviate from the calculated interval.

20 Nitrocellulose lacquer on beech veneered particle board Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Heptanal	111-71-7	Irritation	<0.01-0.01	<0.01	<0.01	<3 and >28 based on odour
		Hexanal	66-25-1	Irritation	0.05-0.28	0.02-0.14	0.02-0.14	>28 based on odour
		Nonanal	124-19-6	Irritation	<0.01	nd	nd	<3 and >28 based on odour
		Pentanal	110-62-3	Irritation	<0.01-0.01	<0.01-0.01	<0.01	7 and >28 based on odour
		2-Decenal	2497-25-8	Irritation	3.20-17.60	2.40-13.20	nd	
		2-Heptenal	2463-63-0	Irritation	3.20-17.60	1.60-8.80	nd	
		2-Nonenal	2463-33-8	Irritation	1.60-8.80	1.6-6.60	1.20-6.60	
		2-Octenal	2363-89-5	Irritation	10.40-57.20	4.00-22.00	nd	
		2-Undecenal	2463-77-6	Irritation	1.60-8.80	nd	nd	
	Esters	Butyl acetate	123-86-4	Irritation	0.04-0.18	0.02-0.08	0.02-0.06	>28 based on odour
	Ketones	Acetone	67-64-1	Irritation	0.04-0.24	0.04-0.22	0.10-0.50	
	Several types	Others		Irritation	<0.6-<3.0	<0.1-<1.2	<0.01-<0.02	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				20.7-113.8	9.5-52.2	1.4-7.4	>28

nd Below the detection limit of the method

21 UV-curing lacquer on beech veneered particle board Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Aldehydes	Acetaldehyde	75-07-0	Irritation	<0.01	<0.01	<0.01	<3 based on odour
		Formaldehyde	50-00-0	Irritation	nd	nd	<0.01-0.02	<3 based on irritation
	Glycol, -ethers, -esters	1-Buthoxy-2-propylacetate	85409-76-3	Irritation	<0.01-0.05	<0.01-0.02	nd	
		Texanol	70657-70-4	Irritation	<0.01-0.04	<0.01-0.04	<0.01-0.03	
	Ketones	Acetone	67-64-1	Irritation	0.12-0.60	0.10-0.50	0.12-0.60	
	Several types	Others		Irritation	<0.01	<0.01-<0.04	<0.01-<0.05	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				0.1-0.7	0.1-0.6	0.1-0.7	<3

nd Below the detection limit of the method

22 Acid curing lacquer on beech veneered particle board Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Alcohols	1-Butanol	71-36-3	Irritation	2.52-13.86	1.28-7.04	0.88-4.84	>28 based on odour
		2-Methyl-1-propanol	78-83-1	Irritation	0.52-2.86	0.24-1.32	0.16-0.88	
	Aldehydes	Formaldehyde	50-00-0	Irritation	3.60-19.80	2.00-11.00	1.28-7.04	>28 based on irritation
		Hexanal	66-25-1	Irritation	0.02-0.08	0.02-0.06	0.02-0.08	>28 based on odour
		2-Heptenal	2463-63-0	Irritation	1.20-6.60	1.20-6.60	1.20-6.60	
	Esters	Butyl acetate	123-86-4	Irritation	0.06-0.30	0.04-0.22	0.02-0.14	
	Glycol, -ethers, - esters	1-Methoxy-2-Propylacetate	108-65-6	Irritation	0.26-1.46	0.06-0.30	0.02-0.12	
	Several types	Others		Irritation	<0.4<1.8	<0.2-<1.0	<0.2-<1.6	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				8.5-46.7	5.0-27.5	3.7-21.3	>28

23 Water borne lacquer on beech veneered particle board Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Esters	Butyl acetate	123-86-4	Irritation	<0.01-0.02	<0.01-0.01	<0.01-0.01	<3 and >28 based on odour
	Glycol,- ethers, -esters	2-(2-Buthoxy-ethoxy-ethanol)	112-34-5	Irritation	3.34-18.34	1.86-10.26	0.74-4.04	>28 based on odour
		1-Buthoxy-2-propanol	15821-83-7	Irritation Others	0.70-3.84	0.40-2.24	0.16-0.88	
		1-Buthoxy-2-propyl acetate	85409-76-3	Irritation	1.46-8.00	0.84-4.64	0.50-2.80	20 and >28 based on odour
		Texanol	70657-70-4	Irritation	0.06-0.32	0.04-0.24	0.04-0.20	
	Ketones	Acetone	67-64-1	Irritation	0.20-1.04	0.06-0.28	0.10-0.50	
	Several types	Others		Irritation	<0.3-<1.8	<0.1-<0.7	<0.1-<0.3	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				6.0-33.4	3.3-18.3	1.6-8.7	>28

24 Polyurethane lacquer on beech veneered particle board Load 0.4 m5/m;. The material forms e.g. part as: - Ceiling - Floor - Table and 6 chairs Load: 2.2 m5/m;. The material forms e.g. part as: - Ceiling, floor and wall lining on all the surfaces of the room - Two bookcase systems	**Essential single substances**			**Comfort and health evaluation by load 0.4 - 2.2 m5/m;**				**Indoor-relevant time-value by load 0.4 and 2.2 m5/m; [days]**
	Type of substance	**Substance**	**CAS no.**	**Type of effect**	**c/LCI, 3-4 days**	**c/LCI, 9-11 days**	**c/LCI, 27-28 days**	
	Esters	Butyl acetate	123-86-4	Irritation	0.08-0.40	0.04-0.18	0.02-0.08	>28 based on odour
	Glycol , -ethers, -esters	1-Methoxy-2-propyl acetate	108-65-6	Irritation	1.80-9.90	1.18-6.46	0.78-3.74	>28 based on odour
	Ketones	Acetone	67-64-1	Irritation	0.04-0.26	0.04-0.26	0.08-0.42	
	Hydrocarbons	C2-Alkyl-benzenes		Irritation	0.88-4.84	0.50-2.78	0.08-0.48	
	Several types	Others		Irritation	<0.1-<0.3	<0.04-<0.1	<0.01-<0.1	
	Summary: S-values (3c/LCI) and indoor-relevant time-value respectively				2.9-15.7	1.8-9.8	0.9-4.8	>28

Appendix 9
Literature List

Appendix 9
Additional Literature on Project Related Topics

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Appendix 10
List of Synonyms

Appendix 10: List of synonyms

Acetate C-7, see Heptyl acetate CAS 112-06-1

Acetic acid α -ethylhexyl ester, see 2-Ethyl hexyl acetate CAS 103-09-3

Acetic acid 2-methoxy propyl ester, see 2-Methoxy-1-propyl acetate CAS 70657-70-4

Acetic acid 2-methylpropyl ester, see Isobutylacetate CAS 110-19-0

Acetic acid n-butyl ester, see Butyl acetate CAS 123-86-4

Acetic acid, 2-ethoxyethyl ester, see 2-Ethoxy ethyl acetate CAS 111-15-9

α -Acetoxytoluene, see Benzyl acetate CAS 140-11-4

Acraldehyde, see Acrolein CAS 107-02-8

Acrylaldehyde, see Acrolein CAS 107-02-8

Aldehyde C10, see n-Decanal CAS 112-31-2

Aldehyde C3, see Propanal CAS 123-38-6

Aldehyde C4, see Butanal CAS 123-72-8

Aldehyde C5, see Pentanal CAS 110-62-3

Aldehyde C6, see Hexanal CAS 66-25-1

Aldehyde C7, see Heptanal CAS 111-71-7

Aldehyde C8, see Octanal CAS 124-13-0

Aldehyde C9, see Nonanal CAS 124-19-6

Amyl alcohol, see 1-Pentanol CAS 71-41-0

n-Amyl alcohol, see 1-Pentanol CAS 71-41-0

Amyl aldehyde, see Pentanal CAS 110-62-3

n-Amyl formate, see Pentyl formate CAS 638-49-3

n-Amyl methyl ketone, see 2-Heptanone CAS 110-43-0

Amyl methyl ketone, see 2-Heptanone CAS 110-43-0

Amyl vinyl alcohol, see 1-Octen-3-ol CAS 3319-86-4

Amyl vinyl carbinol, see 1-Octen-3-ol CAS 3319-86-4

Anone, see Cyclohexanone CAS 108-94-1

Artificial almond oil, see Benzaldehyde CAS 100-52-7

Artificial ant oil, see Furfural CAS 98-01-1

α ,α -Azobisisobutylonitrile, see 2,2'-Azobisisobutyronitrile CAS 78-67-1

Azobisisobutylonitrile, see 2,2'-Azobisisobutyronitrile CAS 78-67-1

2,2'-Azobis(2-methylpropionitrile), see 2,2'-Azobisisobutyronitrile CAS 78-67-1

Benzal alcohol, see Benzyl alcohol CAS 100-51-6

Benzenemethanol, see Benzyl alcohol CAS 100-51-6

Benzenol, see Phenol CAS 108-95-2

Benzoyl alcohol, see Benzyl alcohol CAS 100-51-6

Benzyl ethanoate, see Benzyl acetate CAS 140-11-4

Butal, see Butanal CAS 123-72-8

Butaldehyde, see Butanal CAS 123-72-8

n-Butanal, see Butanal CAS 123-72-8

Butanaldehyde, see Butanal CAS 123-72-8

Butane carboxylic acid, see Pentanoic acid CAS 109-52-4

Butanic acid, see Butanoic acid CAS 107-92-6

1-Butanol, see Butanol CAS 71-36-3

Butan-1-ol, see Butanol CAS 71-36-3

n-Butanol, see Butanol CAS 71-36-3

4-Butanolide, see Butyrolactone CAS 96-48-0

1,2-Butanolide, see Butyrolactone CAS 96-48-0

1,2-Butanolide, see Butyrolactone CAS 96-48-0

1,4-Butanolide, see Butyrolactone CAS 96-48-0

2-Butoxy-1-methylethyl acetate, see 1-Butoxy-2-propyl acetate CAS 85409-76-3

Butoxydiethylene glycol, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

Butoxydiglycol, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

2-(2-Butoxyethoxy)ethanol, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

1-Butyl alcohol, see Butanol CAS 71-36-3

n-Butyl alcohol, see Butanol CAS 71-36-3

Butyl aldehyde, see Butanal CAS 123-72-8

n-Butyl n-butanoate, see Butyl butyrate CAS 109-21-7

n-Butyl butyrate, see Butyl butyrate CAS 109-21-7

n-Butyl n-butyrate, see Butyl butyrate CAS 109-21-7

Butyl carbitol, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

Butyl dioxitol, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

Butyl ethanoate, see Butyl acetate CAS 123-86-4

Butyl ethyl ketone, see 3-Heptanone CAS 106-35-4

n-Butyl ethyl ketone, see 3-Heptanone CAS 106-35-4

Butyl formal, see Pentanal CAS 110-62-3

Butyl hydroxide, see Butanol CAS 71-36-3

Butylacetat, see Butyl acetate CAS 123-86-4

3-Butylacrolein, see 2-Heptenal CAS 2463-63-0

Butylacrolein, see 2-Heptenal CAS 2463-63-0

Butylbenzenes, see C4-Alkylbenzenes CAS ?

n-Butylcarbinol, see 1-Pentanol CAS 71-41-0

Butyldiglycol, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

n-Butylene, see Butene CAS 106-98-9

n-Butyral, see Butanal CAS 123-72-8

Butyl aldehyde, see Butanal CAS 123-72-8

Butyraldehyd, see Butanal CAS 123-72-8

n-Butyraldehyde, see Butanal CAS 123-72-8

Acetic acid, phenylmethyl ester, see Benzyl acetate CAS 140-11-4

Phenylmethyl acetate, see Benzyl acetate CAS 140-11-4

α -Acetoxytoluene, see Benzyl acetate CAS 140-11-4

Benzyl ethanoate, see Benzyl acetate CAS 140-11-4

Butyric acid, see Butanoic acid CAS 107-92-6

Butyric acid lactone, see Butyrolactone CAS 96-48-0

Butyric aldehyde, see Butanal CAS 123-72-8

4-Butyrolactone, see Butyrolactone CAS 96-48-0

α -Butyrolactone, see Butyrolactone CAS 96-48-0

γ -Butyrolactone, see Butyrolactone CAS 96-48-0

Cajeputene, see Limonene CAS 138-86-3

Capraldehyde, see n-Decanal CAS 112-31-2

Capric aldehyde, see n-Decanal CAS 112-31-2

Caprinaldehyde, see n-Decanal CAS 112-31-2

Caproic aldehyde, see Hexanal CAS 66-25-1

Capronaldehyde, see Hexanal CAS 66-25-1

n-Caproylaldehyde, see Hexanal CAS 66-25-1

Caprylic aldehyde, see Octanal CAS 124-13-0

Carbolic acid, see Phenol CAS 108-95-2

Carene-2, see 2-Carene CAS 4497-92-1

Δ 3-Carene, see 3-Carene CAS 13466-78-9

S-3-Carene, see 3-Carene CAS 13466-78-9

4-Carvomenthenol, see 4-Terpineol CAS 562-74-3

Cellosolve acetate, see 2-Ethoxy ethyl acetate CAS 111-15-9

Cinene, see Limonene CAS 138-86-3

Cumene, see C3-Alkylbenzenes CAS ?

Cyclohexyl ketone, see Cyclohexanone CAS 108-94-1

Cymene, see C4-Alkylbenzenes CAS ?

d-Verbenone, see Verbenone CAS 18309-32-5

n-Decaldehyde, see n-Decanal CAS 112-31-2

Decanal, see n-Decanal CAS 112-31-2

Decanaldehyde, see n-Decanal CAS 112-31-2

Decane-2,9-dione, see 2,9-Decane dione CAS ?

Decanes, see Alkanes (C7-C12) CAS ?

2-Decen-1-al, see 2-Decenal CAS 2497-25-8

Decenaldehyde, see 2-Decenal CAS 2497-25-8

1-Decyl aldehyde, see n-Decanal CAS 112-31-2

n-Decyl aldehyde, see n-Decanal CAS 112-31-2

4-Deoxytetronic acid, see Butyrolactone CAS 96-48-0

2,2'-Dicyano-2,2'-azopropane, see 2,2'-Azobisisobutyronitrile CAS 78-67-1

Diethyl carbinol, see 3-Pentanol CAS 584-02-1

Diethylbenzenes, see C4-Alkylbenzenes CAS ?

Diethylene glycol monobutyl ether, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

Diethylene glycol n-butyl ether, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

Diglycol monobutyl ether DGBE, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

4-Dihydro-2(3H)-furanone Hydroxybutanoic acid lactone, see

Butyrolactone CAS 96-48-0

Dimethyl ketone, see Acetone CAS 67-64-1

2,2-Dimethyl-3-methylene- bicyclo(2.2.1)heptane, see Camphene CAS 79-92-5

Dimethylbenzene, see C2-Alkylbenzenes CAS 1330-20-7

Dimethylformaldehyde, see Acetone CAS 67-64-1

Dimethylketal, see Acetone CAS 67-64-1

Dipentene, see Limonene CAS 138-86-3

dl-Limonene, see Limonene CAS 138-86-3

dl-Limonene oxide, see Limonene oxide CAS 1195-97-2

dl-p-Mentha-1,8-diene, see Limonene CAS 138-86-3

Dodecanes, see Alkanes (C7-C12) CAS ?

Durene, see C4-Alkylbenzenes CAS ?

EGEEA, see 2-Ethoxy ethyl acetate CAS 111-15-9

Enanthal, see Heptanal CAS 111-71-7

Enanthaldehyde, see Heptanal CAS 111-71-7

Enanthic alcohol, see 1-Heptanol CAS 111-70-6

Enanthole, see Heptanal CAS 111-71-7

Ethanal, see Acetaldehyde CAS 75-07-0

Ethoxyethyl acetate, see 2-Ethoxy ethyl acetate CAS 111-15-9

Ethoxy hexyl acetate, see 2-Ethoxy hexyl acetate CAS ?

2-Ethoxyethanol acetate, see 2-Ethoxy ethyl acetate CAS 111-15-9

β -Ethoxyethyl acetate, see 2-Ethoxy ethyl acetate CAS 111-15-9

Ethyl glycol acetate, see 2-Ethoxy ethyl acetate CAS 111-15-9

Ethylacetic acid, see Butanoic acid CAS 107-92-6

Ethylbenzol, see Ethylbenzene CAS 100-41-4

Ethylbutylketon, see 3-Heptanone CAS 106-35-4

Ethylene aldehyde, see Acrolein CAS 107-02-8

Ethylene glycol ethyl ether acetate, see 2-Ethoxy ethyl acetate CAS 111-15-9

2-Ethylhexanyl acetate, see 2-Ethyl hexyl acetate CAS 103-09-3

β -Ethylhexyl acetate, see 2-Ethyl hexyl acetate CAS 103-09-3

2-Ethylhexyl ethanoate, see 2-Ethyl hexyl acetate CAS 103-09-3

Fenol, see Phenol CAS 108-95-2

Formaldehyde butyl butylacetal, see Formaldehyde dibutylacetal CAS ?

Formaldehyde isobutyl butylacetal, see Formaldehyde butyl isobutylacetal CAS?

Formaldehyde isobutyl isobutylacetal, see Formaldehyde diisobutylacetal CAS 2568-91-4

Formalin, see Formaldehyde CAS 50-00-0

Formic aldehyde, see Formaldehyde CAS 50-00-0

Formol, see Formaldehyde CAS 50-00-0

2-Formylfuran, see Furfural CAS 98-01-1

Fural, see Furfural CAS 98-01-1

2-Furanaldehyde, see Furfural CAS 98-01-1

2-Furancarbonal, see Furfural CAS 98-01-1

2-Furancarboxaldehyde, see Furfural CAS 98-01-1

2-Furfural, see Furfural CAS 98-01-1

Furfurole, see Furfural CAS 98-01-1

α -Furole, see Furfural CAS 98-01-1

2-2-Furyl-methanal, see Furfural CAS 98-01-1

Furylaldehyde, see Furfural CAS 98-01-1

Hemimellitine, see C3-Alkylbenzenes CAS ?

Heptaldehyde, see Heptanal CAS 111-71-7

n-Heptaldehyde, see Heptanal CAS 111-71-7

Heptan-1-ol, see 1-Heptanol CAS 111-70-6

Heptan-2-one, see 2-Heptanone CAS 110-43-0

Heptan-3-one, see 3-Heptanone CAS 106-35-4

Heptanes, see Alkanes (C7-C12) CAS ?

n-Heptanol, see 1-Heptanol CAS 111-70-6

Heptanol formate, see Heptyl formate CAS 112-23-2

Heptanyl acetate, see Heptyl acetate CAS 112-06-1

2-Hepten-1-al, see 2-Heptenal CAS 2463-63-0

1-Heptyl acetate, see Heptyl acetate CAS 112-06-1

Heptyl acetate, see Heptyl acetate CAS 112-06-1

n-Heptyl acetate, see Heptyl acetate CAS 112-06-1

Heptyl alcohol, see 1-Heptanol CAS 111-70-6

Heptyl aldehyde, see Heptanal CAS 111-71-7

Heptyl formate, see Heptyl formate CAS 112-23-2

Heptyl formiate, see Heptyl formate CAS 112-23-2

n-Heptyl methanoate, see Heptyl formate CAS 112-23-2

Heptyl methyl ketone, see 2-Nonanone CAS 821-55-6

Hexaldehyde, see Hexanal CAS 66-25-1

1-Hexanal, see Hexanal CAS 66-25-1

Hexanaldehyde, see Hexanal CAS 66-25-1

Hexyl methyl ketone, see 2-Octanone CAS 111-13-7

Hexylaldehyde, see Hexanal CAS 66-25-1

4-Hydroxy-butyric acid, γ -lactone, see Butyrolactone CAS 96-48-0

Hydroxybenzene, see Phenol CAS 108-95-2

1-Hydroxybutane, see Butanol CAS 71-36-3

γ -Hydroxybutyric acid cyclic ester, see Butyrolactone CAS 96-48-0

4-Hydroxybutyric acid lactone, see Butyrolactone CAS 96-48-0

4-Hydroxybutyric acid, γ -lactone, see Butyrolactone CAS 96-48-0

1-Hydroxyheptane, see 1-Heptanol CAS 111-70-6

1-Hydroxymethylpropane, see 2-Methyl-1-propanol CAS 78-83-1

α -Hydroxytoluene, see Benzyl alcohol CAS 100-51-6

Hydroxytoluene, see Benzyl alcohol CAS 100-51-6

Isoamyl alcohol, see 3-Pentanol CAS 584-02-1

Isobutyl alcohol, see 2-Methyl-1-propanol CAS 78-83-1

Isodiprene, see 3-Carene CAS 13466-78-9

Isodurene, see C4-Alkylbenzenes CAS ?

4-Isopropyl-1-methyl-1,5-cyclohexadiene, see α -Phellandrene CAS 99-83-2

5-Isopropyl-2-methyl-1,3-cyclohexadiene, see α -Phellandrene CAS 99-83-2

Isopropylbenzene, see C3-Alkylbenzenes CAS ?

Isopropylcarbinol, see 2-Methyl-1-propanol CAS 78-83-1

Ketohexamethylene, see Cyclohexanone CAS 108-94-1

p-Mentha-1,3-diene, see α -Terpinene CAS 99-86-5

1,8(9)-p-Menthadiene, see Limonene CAS 138-86-3

p-Menthane, see Limonene CAS 138-86-3

p-Menth-1-en-8-ol, see α -Terpineol CAS 98-55-5

1-para-Menthen-4-ol, see 4-Terpineol CAS 562-74-3

Mesitylene, see C3-Alkylbenzenes CAS ?

Methaldehyde, see Formaldehyde CAS 50-00-0

Methanal, see Formaldehyde CAS 50-00-0

1-Methoxy-2-acetoxypropane, see 1-Methoxy-2-propyl acetate CAS 108-

1-Methoxy-2-acetoxypropane, see 1-Methoxy-2-propyl acetate CAS 108-65-6

2-Methoxy-1-methylethyl acetate, see 1-Methoxy-2-propyl acetate CAS 108-65-6

Methyl aldehyde, see Formaldehyde CAS 50-00-0

Methyl heptyl ketone, see 2-Nonanone CAS 821-55-6

Methyl hexyl ketone, see 2-Octanone CAS 111-13-7

Methyl pentyl ketone, see 2-Heptanone CAS 110-43-0

Methyl propanoic acid, monoester with 2,2,4-trimethyl-1,3-pentanediol, see

2,2,4-Trimethyl-1,3-pentanediol, monoiso-butyrate CAS 25265-77-4

2-Methyl propanol, see 2-Methyl-1-propanol CAS 78-83-1

Methyl propyl benzenes, see C4-Alkylbenzenes CAS ?

Methyl toluene, see C2-Alkylbenzenes CAS 1330-20-7

4-Methyl-1-(1-methylethyl)-3-cyclohexen-1-ol, see 4-Terpineol CAS 562-74-3

7-Methyl-3-methylene-1,6-octadiene, see ß-Myrcene CAS 123-35-3

1-Methyl-4-isopropylcyclohexadiene-1,3, see α -Terpinene CAS 99-86-5

1-Methyl-4-isopropylcyclohexadiene-1,4, see γ -Terpinene CAS 99-85-4

Methylacetaldehyde, see Propanal CAS 123-38-6

Methylene oxide, see Formaldehyde CAS 50-00-0

3-Methylene-7-methyl-1,6-octadiene, see ß-Myrcene CAS 123-35-3

1-Methyl-4-isopropenyl-1-cyclohexene, see Limonene CAS 138-86-3

2-Methyl-5-isopropyl-1,3-cyclohexadiene, see α -Phellandrene CAS 99-83-2

1-Methyl-4-isopropyl-1,3-cyclohexadiene, see α -Terpinene CAS 99-86-5

2-Methyl-5-(1-methylethyl)-1,3-cyclohexadiene, see α -Phellandrene CAS 99-83-2

Methylolpropane, see Butanol CAS 71-36-3

2-Methylpropan-1-ol, see 2-Methyl-1-propanol CAS 78-83-1

2-Methyl-1-propyl acetate, see Isobutylacetate CAS 110-19-0

2-Methylpropyl alcohol, see 2-Methyl-1-propanol CAS 78-83-1

β -Methylpropyl ethanoate, see Isobutylacetate CAS 110-19-0

Myrcene, see ß-Myrcene CAS 123-35-3

1-Nonaldehyde, see Nonanal CAS 124-19-6

1-Nonanal, see Nonanal CAS 124-19-6

Nonanes, see Alkanes (C7-C12) CAS ?

Nonan-2-one, see 2-Nonanone CAS 821-55-6

Non-2-enal, see 2-Nonenal CAS 2463-33-8

1-Nonyl aldehyde, see Nonanal CAS 124-19-6

Nopinene, see ß-Pinene CAS 127-91-3

O-Butyl diethylene glycol, see 2-(2-Butoxyethoxy)-ethanol CAS 112-34-5

Oct-2-enal, see 2-Octenal CAS 2363-89-5

1-Octanal, see Octanal CAS 124-13-0

Octanaldehyde, see Octanal CAS 124-13-0

Octanes, see Alkanes (C7-C12) CAS ?

Octene-3-one, see 4-Octene-3-one CAS ?

n-Octyl aldehyde, see Octanal CAS 124-13-0

2-Oxolanone, see Butyrolactone CAS 96-48-0

Oxomethane, see Formaldehyde CAS 50-00-0

Oxybenzene, see Phenol CAS 108-95-2

Oxytol acetate, see 2-Ethoxy ethyl acetate CAS 111-15-9

Paraform, see Formaldehyde CAS 50-00-0

Pelargonic aldehyde, see Nonanal CAS 124-19-6

n-Pentanal, see Pentanal CAS 110-62-3

n-Pentanoic acid, see Pentanoic acid CAS 109-52-4

n-Pentanoic acid, see Pentanoic acid CAS 109-52-4

Pentanoic acid, see Pentanoic acid CAS 109-52-4

n-Pentanol, see 1-Pentanol CAS 71-41-0

Pentan-1-ol, see 1-Pentanol CAS 71-41-0

Pentan-3-ol, see 3-Pentanol CAS 584-02-1

Pentanol, see 1-Pentanol CAS 71-41-0

Pentanol-1, see 1-Pentanol CAS 71-41-0

Pentanol-3, see 3-Pentanol CAS 584-02-1

Pent-2-enal, see 2-Pentenal CAS 1576-87-0

1-Penten-3-one, see Ethyl vinyl ketone CAS 1129-58-9

Pentyl alcohol, see 1-Pentanol CAS 71-41-0

n-Pentyl formate, see CAS ?

Pentyl formiate, see CAS ?

Pentyloxirane, see Pentyloxiran CAS 5063-65-0

PGBE, see 1-Butoxy-2-propanol CAS 5131-66-8

PGBE, see 2-Butoxy-1-propanol CAS 15821-83-7

PGBEA, see 1-Butoxy-2-propyl acetate CAS 85409-76-3

Phenyl hydrate, see Phenol CAS 108-95-2

Phenyl hydroxide, see Phenol CAS 108-95-2

Phenyl methanol, see Benzyl alcohol CAS 100-51-6

Phenylethane, see Ethylbenzene CAS 100-41-4

Phenylic acid, see Phenol CAS 108-95-2

Phenylic alcohol, see Phenol CAS 108-95-2

Phenylmethanal, see Benzaldehyde CAS 100-52-7

Phenylmethyl acetate, see Benzyl acetate CAS 140-11-4

Phenylmethyl acetate, see Benzyl acetate CAS 140-11-4

Pimelic ketone, see Cyclohexanone CAS 108-94-1

2-Pinene, see α -Pinene CAS 80-56-8

2(10)-Pinene, see ß-Pinene CAS 127-91-3

Prehnitine, see C4-Alkylbenzenes CAS ?

Propaldehyde, see Propanal CAS 123-38-6

1-Propanecarboxylic acid, see Butanoic acid CAS 107-92-6

1,2-Propanediol diacetate, see Propylene glycol diacetate CAS ?

2-Propanone, see Acetone CAS 67-64-1

Propanone, see Acetone CAS 67-64-1

2-Propenal, see Acrolein CAS 107-02-8

Prop-2-en-1-al, see Acrolein CAS 107-02-8

Propenal, see Acrolein CAS 107-02-8

Propionaldehyde, see Propanal CAS 123-38-6

Propyl aldehyde, see Propanal CAS 123-38-6

Propylacetic acid, see Pentanoic acid CAS 109-52-4

n-Propylbenzene, see C3-Alkylbenzenes CAS ?

Propylcarbinol, see Butanol CAS 71-36-3

Propylene glycol n-butyl ether, see 1-Butoxy-2-propanol CAS 5131-66-8

Propylene glycol n-butyl ether, see 2-Butoxy-1-propanol CAS 15821-83-7

Propylene glycol n-butyl ether acetate, see 1-Butoxy-2-propyl acetate CAS 85409-76-3

Propyleneglycol methyl ether acetate, see 2-Methoxy-1-propyl acetate CAS 70657-70-4

Propyleneglycol monomethyl ether acetate, see 1-Methoxy-2-propyl acetate CAS 108-65-6

Propylformic acid, see Butanoic acid CAS 107-92-6

Propylmethanol, see Butanol CAS 71-36-3

Pseudocumene, see C3-Alkylbenzenes CAS ?

Pseudocumene, see C3-Alkylbenzenes CAS ?

Pseudopinene, see ß-Pinene CAS 127-91-3

Pyroacetic acid, see Acetone CAS 67-64-1

Terpenol, see α -Terpineol CAS 98-55-5

gamma-Terpinene, see γ -Terpinene CAS 99-85-4

4-Terpinenol, see 4-Terpineol CAS 562-74-3

Terpinen-4-ol, see 4-Terpineol CAS 562-74-3

Terpinenol-4, see 4-Terpineol CAS 562-74-3

δ -1,8-Terpodiene, see Limonene CAS 138-86-3

Tetrahydro-2-furanone, see Butyrolactone CAS 96-48-0

Tetrametylbenzenes, see C4-Alkylbenzenes CAS ?

Texanol, see 2,2,4-Trimethyl-1,3-pentanediol, monoiso-butyrate CAS 25265-77-4

α -Toluenol, see Benzyl alcohol CAS 100-51-6

4,7,7-Trimethyl-3-norcarene, see 3-Carene CAS 13466-78-9

3,7,7-Trimethyl-bicyclo(4.1.0)hept-3-ene, see 3-Carene CAS 13466-78-9

Trimethylbenzenes, see C3-Alkylbenzenes CAS ?

2,6,6-Trimethylbicyclo(3.1.1)-2-hept-2-ene, see α -Pinene CAS 80-56-8

3,7,7-Trimethylbicyclo(4.1.0)hept-3-ene, see 3-Carene CAS 13466-78-9

(1R-cis)-4,6,6-Trimethylbicyclo (3.1.1) hept-3-en-2-one, see Verbenone CAS 18309-32-5

4,6,6-Trimethylbicyklo(3,1,1)hept-3-en, see α -Pinene CAS 80-56-8

α ,α ,4-Trimethyl-3-cyclohexene-1-methanol, see α -Terpineol CAS 98-55-5

3,7,7-Trimethyl-3-norcarene, see 3-Carene CAS 13466-78-9

Undecanes, see Alkanes (C7-C12) CAS ?

Undec-2-enal, see 2-Undecenal CAS 2463-77-6

Valeral, see Pentanal CAS 110-62-3

Valerianic acid, see Pentanoic acid CAS 109-52-4

Valerianic aldehyde, see Pentanal CAS 110-62-3

n-Valeric acid, see Pentanoic acid CAS 109-52-4

n-Valeric aldehyde, see Pentanal CAS 110-62-3

Xylol, see C2-Alkylbenzenes CAS 1330-20-7

Xylole, see C2-Alkylbenzenes CAS 1330-20-7

Xylene, isomers, see C2-Alkylbenzenes CAS 1330-20-7